January 23, 2009

APPENDIX A

CURRICULUM VITAE FOR VICTOR J. BIERMAN, JR.

Victor J. Bierman, Jr., Ph.D.

Senior Scientist LimnoTech

Principal Expertise

- Water Quality
- Eutrophication
- Chemical Fate Assessment

- Toxic Chemical Modeling
- Hydrology
- Regulatory Compliance

Education

- Ph.D. Environmental Engineering
 University of Notre Dame, Notre Dame, Indiana, 1974
- M.S. Physics
 University of Notre Dame, Notre Dame, Indiana, 1971
- A.B. Science Villanova University, Villanova, Pennsylvania, 1966

Experience Summary

Dr. Bierman has 35 years of experience in the development and application of water quality models for eutrophication and the transport and fate of toxic chemicals. This work has led to his publication of over 100 technical papers and reports. He is a former Associate Professor in the Department of Civil Engineering at the University of Notre Dame, and a former U.S. EPA National Expert in Environmental Exposure Assessment. As an LTI Senior Scientist, Dr. Bierman conducts research and development on projects for Federal, state and regional government clients. He also provides expert review, litigation support, and expert testimony on a variety of environmental issues for industrial, regulatory and private clients.

Dr. Bierman is a leading expert in the assessment and solution of problems related to nutrients, nuisance algal blooms, nitrogen fixation, hypoxia, exotic species, and ecosystem processes. He has conducted studies in watersheds, lakes, rivers, estuaries and coastal marine systems. This experience has included data synthesis, expert review, and development and application of mass balance models. Dr. Bierman is also a leading expert in toxic chemical transport, fate, partitioning and bioaccumulation. He has conducted assessment studies in major river systems, estuaries, and the Great Lakes, and remedial investigations at U.S. EPA Superfund sites. These studies have included organic chemicals, heavy metals, sediment processes, and mass balance modeling.

Projects conducted by Dr. Bierman include eutrophication studies in the Great Lakes, Saginaw Bay, the Gulf of Mexico, Chesapeake Bay, the Potomac Estuary, Lake Okeechobee and the Florida Everglades. They also include remedial investigations for contaminated sediments at Superfund sites in the Hudson, Fox and Kalamazoo Rivers, and toxic chemical transport and fate studies in the Great Lakes, Green Bay, Saginaw Bay, the Columbia River, and the Delaware and Potomac River Estuaries. Clients have included Federal agencies such as U.S. EPA and the National Oceanic and Atmospheric Administration; regional agencies such as the Metropolitan Washington Council of Governments, South Florida Water Management District, Delaware River Basin Commission, and the Port of Portland; and various other

state and local government agencies. Clients have also included private sector industries and environmental organizations.

Key accomplishments by Dr. Bierman include synthesis of results from five different eutrophication models, including his own model of Saginaw Bay, to develop target phosphorus loadings to the Great Lakes as part of the 1978 Water Quality Agreement between the U.S. and Canada; modeling of hypoxia in the Gulf of Mexico to assess the influence of nutrient loadings from the Mississippi River Basin and produced water discharges from oil and gas drilling activities; transport and fate modeling of PCBs as part of the Hudson River Reassessment RI/FS; development of a coupled phytoplankton-exotic species-PCB model of Saginaw Bay, Lake Huron; development of models for PCB total maximum daily loads (TMDLs) for the Delaware and Potomac River Estuaries; modeling of eutrophication and sediment diagenesis in Lake Okeechobee; modeling of phosphorus transport and fate in the Florida Everglades; and development of a model to support a dioxin TMDL in the Columbia River Basin.

Litigation Support within the Last Ten Years

Litigation Support for a Food Processor in the Illinois River Watershed. 2006-Present. Providing consulting and expert witness services pertaining to phosphorus impacts in the Illinois River Watershed.

Litigation Support for a Former Manufactured Gas Plant. 2004-2005. Expert Witness. Provided consulting and expert witness services pertaining to contaminant transport and fate at the site of a former manufactured gas plant.

Litigation Support for an Industrial Discharger on the Ohio River. 2004-2005. Expert Witness. Conducted an investigation of hydrodynamics, sediment transport and chemical transport and fate in the Ohio River. Prepared a written expert opinion report, was deposed, and provided technical review of opposing expert reports.

Litigation Support for Wastewater Treatment Plant Permit Challenge. 2004-2005. Expert Witness. Conducted investigations of constituent transport and fate in the Ohio River, and water quality standards applicable to the Ohio River in Kentucky and Ohio.

Litigation Support for Hudson River Natural Resource Damage Assessment. 2003-2005. Consulting Expert. Investigated PCB transport and fate issues at the U.S. EPA Hudson River Superfund Site for the U.S. Department of Justice.

Litigation Support for U.S. Department of Justice in Case Involving Municipal Discharger. 1994-1995 and 1998-1999. Expert Witness. Conducted transport and fate analysis for solids and toxic chemicals discharged from the Hammond Sanitary District Plant. Prepared written expert opinion report, was deposed, and provided technical review of opposing expert reports.

Litigation Support and Expert Testimony for a Class Action Suit Involving Pesticide Contamination. 1996-1999. Expert Witness. Conducted an assessment of sources, environmental distribution and fate of Mirex at an EPA Superfund Site in Salem, Ohio. Prepared technical affidavit, was deposed, and provided technical review of opposing expert reports.

Compensation

My hourly billing rate for work related to preparation of this expert report is \$250. My hourly billing rate for testimony (deposition and trial) is \$375.

Professional and Academic Appointments

Senior Scientist Limno-Tech, Inc.

2001-Present Greensboro, North Carolina

Associate Vice President Limno-Tech, Inc. 1997-2001 Ann Arbor, Michigan

Senior Scientist Limno-Tech, Inc. 1992-1997 South Bend, Indiana

Senior Project Manager Limno-Tech, Inc. 1990-1992 South Bend, Indiana

Adjunct Associate Professor Dept. of Civil Engineering & Geological Sciences

1990-1992 University of Notre Dame, Notre Dame, Indiana

Associate Professor Department of Civil Engineering

1986-1990 University of Notre Dame, Notre Dame, Indiana

Environmental Scientist Environmental Research Laboratory

1981-1986 U.S. Environmental Protection Agency, Narragansett,

Rhode Island

EPA National Expert in Environmental

Exposure Assessment

Adjunct Associate Professor Department of Civil and Environmental Engineering 1985-1986

University of Rhode Island, Kingston, Rhode Island

Environmental Scientist Large Lakes Research Station

1974-1981 U.S. Environmental Protection Agency, Grosse Ile,

Michigan

Systems Ecologist Cranbrook Institute of Science 1974 Bloomfield Hills, Michigan

Graduate Student Departments of Physics & Civil Engineering 1968-1973 University of Notre Dame, Notre Dame, Indiana

Science Teacher Northeast Catholic High School 1966-1968 Philadelphia, Pennsylvania

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Professional Affiliations

American Chemical Society

Water Environment Federation

Estuarine Research Federation

Society of Environmental Toxicology and Chemistry

North American Lake Management Society

American Society of Limnology and Oceanography

International Association for Great Lakes Research

Aquatic Ecosystem Health and Management Society

Selected Professional Activities

Discussion Group Leader, Chesapeake Bay Program Scientific and Technical Advisory Committee Workshop, Modeling in the Chesapeake Bay Program: 2010 and Beyond, Annapolis, MD, January 17-18 2006.

Co-Chair, Session on Contaminant Fate and Transport, Third International Conference on the Remediation of Contaminated Sediments, New Orleans, Louisiana, January 24-27, 2005.

Chair, Special Session on Total Maximum Daily Load (TMDL) for PCBs: Case Study of the Delaware River Estuary. Water Environment Federation, WEFTEC04, New Orleans, Louisiana, October 6, 2004.

Editorial Board, Aquatic Ecosystem Health & Management, Journal of the Aquatic Ecosystem Health and Management Society. 2003-Present.

Member, Modeling Subcommittee of the Monitoring, Modeling and Research Committee, U.S. EPA Gulf of Mexico Program. 1999-Present. Provide expert assistance on design and implementation of a mathematical modeling program to address scientific and management questions related to hypoxia in the Gulf of Mexico.

Co-Chair, 5th International Symposium on Sediment Quality Assessment, Chicago, Illinois, October 16-18, 2002.

Invited Expert, Lake Michigan Mass Balance Sediment Modeling Workshop, U.S. EPA Great Lakes National Program Office. 2001. Provided expert review and technical guidance on alternate modeling approaches for sediment dynamics in the Lake Michigan Mass Balance Study.

Co-Chair, Task Group 4, Gulf of Mexico Hypoxia Assessment, White House Committee on Environment and Natural Resources. 1998-2000. Conducted a quantitative assessment of water quality responses in the Gulf of Mexico to potential changes in nutrient loadings from the Mississippi River Basin.

Invited Expert, Gulf Hypoxia Science Meeting, Gulf of Mexico Hypoxia Assessment. 1999. Provided expert advice on scientific questions related to causes of hypoxia in the Gulf of Mexico.

Member, Technical Advisory Committee, Nutrient Enhanced Coastal Ocean Productivity (NECOP) Program, NOAA. 1992-1995. Provide coordination and technical guidance for physical and water quality modeling activities in the NECOP Program.

White Paper Author, Workshop on Reducing Uncertainty in Mass Balance Models of Toxics in the Great Lakes: Lake Ontario Case Study. 1992. Invited to author a "white paper" on model formulations, spatial-temporal resolution and process aggregation for the purpose of guiding workshop discussions.

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Associate Editor, Journal of Great Lakes Research. 1986-1991.

Discussion Leader, Mass Balance Workshop, International Joint Commission. 1990. Participated in development of management questions to define levels of mass balance modeling of toxic chemicals in the Great Lakes.

Member, Lake Huron Task Force, International Joint Commission. 1986-1990. Participate in development of surveillance plans, conduct data synthesis and prepare summary reports on water quality conditions in Lake Huron, pursuant to the Water Quality Agreements between the U.S. and Canada.

Task Group Leader, Workshop on Nutrient Cycling/Food Web Interactions for Lake Ontario. 1990. Invited to peer review a proposed Nutrient Cycling/Food Web Model for Lake Ontario.

Invited Expert, Workshop on Sediment and Food Web Effects on Bioaccumulation, U.S. EPA. 1990. Invited to review present understanding and future research approach to bioaccumulation of toxic chemicals.

Invited Expert, Workshop on Mississippi River Plume and Louisiana Shelf Interaction, NOAA. 1989. Invited to review a research plan to study nutrient fluxes, biological productivity and dissolved oxygen depletion as part of a new Coastal Ocean Program.

Member, Technical Advisory Committee, International Association for Great Lakes Research. 1986-1988. Assist the Board of Directors in identifying problems and opportunities in pursuit of long-term research programs to support environmental management in the Great Lakes.

Expert Reviewer, Workshop on Toxic Chemical Loadings in the Great Lakes, International Joint Commission. 1987. Invited to peer review results from three different mathematical models for toxic chemical concentrations in the Great Lakes.

Reviewer, National Sea Grant College Site Team, University of Rhode Island. 1987.

Member, Statistics and Modeling Group, Tributary Loading Workshop, International Joint Commission. 1987. Provided recommendations on monitoring plans and loading estimation techniques for tributaries to the Great Lakes.

Invited Expert, Surveillance Workshop, Great Lakes National Program Office, U.S. EPA. 1986. Invited to participate in a review of present activities and to make recommendations for future programs.

Chairman, Water Quality Working Group, Science and Technical Committee, U.S. EPA Narragansett Bay Project. 1985-1986. Provided technical coordination and program review for water quality-related projects.

Member, Science Advisory Committee, Marine Ecosystems Research Laboratory, Graduate School of Oceanography, University of Rhode Island. 1985-1986. Reviewed research accomplishments, current plans and future direction for the MERL, a Center of Excellence under a Cooperative Agreement between the U.S. EPA and the University of Rhode Island.

Member, Water Quality Group, Northeast Monitoring Program, NOAA. 1983-1985. Provided technical assistance on water quality assessments and mathematical modeling in the Middle Atlantic Bight.

Expert Reviewer, Environmental Program, National Marine Fisheries Service, NOAA. 1984. Served as an outside reviewer for the Environmental Assessment Program of the Northeast Fisheries Center.

Panelist, Eutrophication Symposium, New England Estuarine Research Society. 1984. Invited to participate in a discussion of alternative approaches to the study of eutrophication.

Member, Board of Directors, International Association for Great Lakes Research. 1981-1984. Elected for a three-year term.

Associate Editor, Journal of Great Lakes Research. 1979-1983.

Member, Steering Committee for Implementation of Ecosystem Approach Workshop, International Joint Commission. 1981-1982. Served as a technical consultant for ecosystem modeling related to management issues in the Great Lakes.

Member, Technical Advisory Committee, Chesapeake Bay Program, U.S. EPA. 1979-1982. Served as a technical consultant on eutrophication and water quality modeling.

Expert Witness, Public Hearings on Phosphorus Management Strategies for the Great Lakes. International Joint Commission, Windsor, Ontario. 1980.

Ad Hoc Member, Modeling Sub-Group, Phosphorus Management Strategies Task Force, International Joint Commission. 1979. Served as a technical consultant on the scientific basis for development of the target phosphorus loads for the Great Lakes as part of the 1978 Water Quality Agreement.

Member, Task Group III, A Technical Group to Review Phosphorus Loadings, U.S.-Canada Water Quality Agreement Re-Negotiation. 1978. Synthesized results from five different mathematical models and developed target phosphorus loading recommendations for the major basins in the Great Lakes.

Ad Hoc Member, Expert Committee on Ecosystems Aspects, International Joint Commission. 1977. Reviewed the Hydroscience water quality model of Lake Ontario.

Expert Witness, Conservation Committee Hearings, Michigan House of Representatives. 1977. Testified on House Bills 4015 and 4023 to ban phosphates in detergents.

Member, Inter-Agency Technical Advisory Group, U.S. Army Corps of Engineers Lake Erie Project. 1975-1977. Served as a technical consultant on projects related to eutrophication and water quality modeling of Lake Erie.

Participant in U.S.-U.S.S.R. Scientific Exchange Meetings. 1976. Moscow, Novosibirsk, Irkutsk, Baikal and Khabarovsk, U.S.S.R.

Selected Experience

Review of Dioxin Issue Paper for San Francisco Bay. 2008. Senior Scientist. Conducted a scientific peer review of a dioxin issue paper for San Francisco Bay under the direction of the San Francisco Estuary Institute.

Review of Watershed and Water Quality Models for Nutrient TMDLs in the Caloosahatchee River Estuary. 2007-2008. Senior Scientist. Conducted a scientific review of a coupled HSPF-EFDC modeling system for nutrient total maximum daily loads (TMDLs) for the Caloosahatchee River Estuary to ensure that nutrient levels are appropriate for restoration of water quality.

Assessment of Mercury Dynamics in the Florida Everglades. 2006-Present. Project Director. Conducting review of available models for mercury transport, fate and bioaccumulation, and the current scientific understanding of mercury dynamics in the Florida Everglades.

Litigation Support for a Food Processor in the Illinois River Watershed. 2006-Present. Providing consulting and expert witness services pertaining to phosphorus impacts in the Illinois River Watershed.

Chesapeake Bay Water Quality Model. 2004-Present. Project Director. Developing new sub-models for estuarine phosphorus dynamics, pH-alkalinity, and algal speciation for the Potomac portion of the third-generation Chesapeake Bay Water Quality Model.

Expert Assistance on Water Quality Modeling for South Florida Water Management District. 2004-Present. Technical Director, Limno-Tech/HydroQual Joint Venture. Providing task order consulting services for hydrologic, hydraulic and water quality modeling to support Comprehensive Everglades Restoration Programs (CERP) and other District programs.

Expert Assistance on Delaware River PCB Model for Total Maximum Daily Load (TMDL). 2002-Present. Senior Scientist. Providing expert technical assistance to Delaware River Basin Commission on model development, application and data needs to support a TMDL for PCBs in the Delaware River Estuary.

Assessment of EPA-Proposed TMDLs for Nutrients in Lake Okeechobee Tributaries. 2006-2007. Project Director. Conducted forecast simulations with the Lake Okeechobee Water Quality Model (LOWQM) to investigate the impacts of the proposed nutrient TMDLs on nitrogen-fixing blue-green algae in the lake, and providing expert assistance to the Everglades Agricultural Area Environmental Protection District and South Florida Water Management District.

Peer Review of Everglades Landscape Model (ELM). 2006-2007. Scientific Facilitator. Conducted scientific facilitation of an independent peer review of the Everglades Landscape Model and its applicability to decision-making for management of nutrients and hydrology in the Florida Everglades.

Peer Review of a Linked HSPF-AQUATOX Modeling System. 2006. Senior Scientist. Conducted a scientific peer review for U.S. EPA on a demonstration application of a linked HSPF-AQUATOX modeling system as an alternate approach for development of numeric nutrient water quality criteria.

Model for PCB Total Maximum Daily Load (TMDL) in Potomac River Estuary. 2005-2007. Project Director. Development and calibration of a transport and fate model for PCBs in the Potomac River Estuary to support development of a TMDL by District of Columbia, Maryland and Virginia.

Assessment of Impacts of Produced Water Discharges on Gulf of Mexico Hypoxia. 2005-2007. Project Director. Used existing models of Gulf of Mexico hypoxia to estimate incremental impacts of produced water discharges from oil and gas platforms.

Expert Assistance on Chesapeake Bay Water Quality Modeling. 2001-2007. Senior Scientist. Provided expert assistance to Metropolitan Washington Council of Governments by conducting a scientific assessment of the Chesapeake Bay Water Quality Model and its use for developing load allocations for nutrients and solids in the Potomac River and Estuary as part of the Chesapeake 2000 Agreement.

Characterization and Conceptual Site Model for Berry's Creek. 2004-2006. Senior Scientist. Conducted site investigation, data assessment and conceptual modeling to support remediation efforts at Universal Oil Products Superfund Site, Berry's Creek, East Rutherford, New Jersey.

Litigation Support for a Former Manufactured Gas Plant. 2004-2005. Expert Witness. Provided consulting and expert witness services pertaining to contaminant transport and fate at the site of a former manufactured gas plant.

Litigation Support for an Industrial Discharger on the Ohio River. 2004-2005. Expert Witness. Conducted an investigation of hydrodynamics, sediment transport and chemical transport and fate in the Ohio River. Prepared a written expert opinion report, was deposed, and provided technical review of opposing expert reports.

Litigation Support for Wastewater Treatment Plant Permit Challenge. 2004-2005. Expert Witness. Conducted investigations of constituent transport and fate in the Ohio River, and water quality standards applicable to the Ohio River in Kentucky and Ohio.

Water Quality Model to Support Biscayne Bay Feasibility Study. 2004-2005. Project Director. Developed a detailed scope of work for an integrated hydrodynamic, sediment transport and water quality model to support a Phase II Feasibility Study of Biscayne Bay, Florida.

Litigation Support for Hudson River Natural Resource Damage Assessment. 2003-2005. Consulting Expert. Investigated PCB transport and fate issues at the U.S. EPA Hudson River Superfund Site for the U.S. Department of Justice.

Expert Assistance on Offshore Siting Study for Relocation of Wastewater Treatment Plant Outfall. 2002-2005. Senior Scientist. Developed regional-scale nutrient loadings to the northeast continental shelf of the U.S. to support a modeling assessment of the proposed relocation of a wastewater treatment plant outfall currently discharging to Jamaica Bay, New York.

Dynamics of Sediment-Water Nutrient Fluxes in the Lower St. Johns River. 2000-2005. Project Director. Conducted literature and field assessments of phosphorus, nitrogen, carbon and oxygen fluxes in the Lower St. Johns River to support a site-specific water quality model.

Expert Assistance on Modeling of Hypoxia in the Gulf of Mexico. 2004. Project Director. Provided expert assistance to Offshore Operators Committee, EPA Region 6 and Minerals Management Service on use of existing models to estimate impacts of produced water discharges.

Expert Assistance on Urban Stream Total Maximum Daily Load (TMDL). 2002-2003. Member, Stakeholder Advisory Group. Provided expert technical assistance to City of Greensboro on development and review of an HSPF model for a fecal coliform TMDL on North Buffalo Creek.

Expert Assistance on Lower St. Johns River Water Quality Model for Nutrient Total Maximum Daily Load (TMDL). 2002-2003. Senior Scientist. Provided expert technical assistance to St. Johns River Water Management District and the U.S. Army Corps of Engineers on model development, calibration and incorporation of nitrogen fixation.

Effect of Zebra Mussels on Cycling and Potential Bioavailability of PCBs: Case Study of Saginaw Bay. 1998-2002. Co-Principal Investigator. Developed a mass balance model to represent the influence of phytoplankton and zebra mussel dynamics on PCB transport, fate and bioavailability in Saginaw Bay, Lake Huron.

Water Quality Assessment for NPDES Permit, Cape Fear River. 2001. Project Director. Conducted data assessment and modeling analyses for dissolved oxygen to support NPDES permit re-issuance for an industrial discharge to the Middle Cape Fear River, North Carolina.

Modeling of PCB Fate and Transport for Hudson River Reassessment RI/FS. 1993-2001. Project Director. Developed mass balance models for hydraulics, solids and PCBs to investigate the impacts of continued No Action and various remedial scenarios on water column and sediment PCB exposures in the Upper Hudson River. Results were used to support the EPA Record of Decision to remediate contaminated sediments in the Upper Hudson River.

Columbia River Channel Deepening Reconsultation Project. 2001. Project Director. Reviewed available data and modeling analyses for hydrodynamics, sediment transport and toxic chemicals to support development of a Biological Assessment for potential impacts on endangered species.

Ottawa River Environmental Hot Spot Delineation and Risk Assessment. 2000-2001. Project Director. Directed assessment of risks posed by existing conditions in the Ottawa River, Ohio, and identification of priority areas for remediation.

Modeling of PCB Fate and Transport in Kalamazoo River. 1999-2000. Senior Scientist. Provided expert advice on development of mass balance models for transport, fate and bioaccumulation of PCBs in the Kalamazoo River, Michigan.

Lake Michigan Ecosystem Model. 1998-2000. Principal Investigator. Developed an ecosystem mass balance model of the lower food web to support the Lake Michigan Mass Balance Study.

Fox River and Green Bay PCB Fate and Transport Model Evaluation. 1997-2000. Senior Scientist. Provided expert advice and consultation on evaluation of alternate PCB transport and fate models for the Fox River and Green Bay, as set forth in an agreement between the State of Wisconsin and several paper companies.

Gulf of Mexico Hypoxia Assessment, White House Committee on Environment and Natural Resources. 1997-1999. Co-Team Leader, Task Group 4. Developed and calibrated a water quality model for hydraulic transport, primary productivity and dissolved oxygen in the northern Gulf of Mexico to assess responses to potential changes in nutrient loadings from the Mississippi River Basin.

Mass Balance Modeling of Hypoxia on the Louisiana Inner Shelf. 1990-1999. Principal Investigator. Development and calibration of a water quality mass balance model for hydraulic transport, primary productivity and bottom water hypoxia in the Mississippi River Plume/Inner Gulf of Mexico Shelf Region.

Expert Assistance on James River Tributary Strategy. 1997-1999. Senior Scientist. Provided expert assistance in reviewing the revised Chesapeake Bay Water Quality Model to support development of a management strategy for the James River in response to a legislative mandate by the State of Virginia.

Litigation Support for U.S. Department of Justice in Case Involving Municipal Discharger. 1994-1995 and 1998-1999. Expert Witness. Conducted transport and fate analysis for solids and toxic chemicals discharged from the Hammond Sanitary District Plant. Prepared written expert opinion report, was deposed, and provided technical review of opposing expert reports.

Litigation Support and Expert Testimony for a Class Action Suit Involving Pesticide Contamination. 1996-1999. Expert Witness. Conducted an assessment of sources, environmental distribution and fate of Mirex at an EPA Superfund Site in Salem, Ohio. Prepared technical affidavit, was deposed, and provided technical review of opposing expert reports.

Sediment Diagenesis Model for Lake Okeechobee. 1997-1998. Project Director. Developed a sediment diagenesis submodel of phosphorus for incorporation into an existing eutrophication mass balance model for Lake Okeechobee. Provided expert assistance to South Florida Water Management District in model application studies.

Caloosahatchee Estuary Hydrodynamic-Salinity Model. 1997. Project Director. Developed and applied a one-dimensional, coupled, hydrodynamic-salinity model. Provided expert assistance to South Florida Water Management District in model calibration and predictive simulations.

Expert Assistance on Chesapeake Bay Water Quality Modeling. 1996-1997. Senior Scientist. Provided expert assistance to Metropolitan Washington Council of Governments in evaluating the rationale for nutrient reduction goals and in technical review of the Chesapeake Bay Watershed and Water Quality Models.

Application of a Coupled Primary Productivity-Exotic Species Model for Saginaw Bay, Lake Huron. 1996-1997. Principal Investigator. Developed and applied an ecosystem mass balance model to investigate water quality responses to changes in external nutrient loadings and zebra mussel dynamics.

Development of Everglades Water Quality Model. 1995-1997. Project Director. Developed and applied a watershed mass balance model for hydraulics, chloride and total phosphorus for the overland areas and canal system in the Florida Everglades.

Litigation Support and Expert Testimony for a Major Chemical Company in Michigan Involving NPDES Permit Violations. 1996. Expert Witness. Conducted transport, fate and effects analysis for toxic chemicals and phosphorus discharged from an industrial outfall. Prepared expert opinion report, provided depositions for two separate cases, and testified at trial in State Circuit Court.

An Ecosystem Modeling Study of Saginaw Bay: Impacts of Long-Term Loading Reductions and Invasion by the Zebra Mussel. 1991-1994. Principal Investigator. Development and application of a mass balance model to assess relative water quality impacts of reductions in phosphorus loadings and potential impacts caused by zebra mussel invasion.

Expert Assistance on Lake Okeechobee Water Quality Modeling for Lake Management. 1993. Project Director. Provided expert assistance in evaluating modeling results, technical guidance for additional modeling simulations, and co-authorship of two peer-reviewed manuscripts with South Florida Water Management District staff.

Development of Caloosahatchee Estuary Salinity Model. 1993. Project Director. Developed and applied a one-dimensional salinity mass balance model, and determined steady-state salinity profiles in the Caloosahatchee Estuary for a suite of freshwater inflows from Lake Okeechobee.

Limnological Studies of Nitrogen Impacts on the Lake Okeechobee Ecosystem. 1993. Project Director. Conducted literature review, data assessment and empirical modeling to understand and potentially control nitrogen impacts on Lake Okeechobee.

Testing the Use of Mass Balance Models for NPDES Permit Development to Protect Sediment Quality. 1992-1993. Project Director. Development and test site applications of a mass balance modeling framework for implementing sediment quality criteria for hydrophobic organic chemicals and heavy metals.

St. Joseph River Combined Sewer Overflows Impact Assessment for the City of South Bend, Indiana in Support of the Development of Control Strategies. 1991-1993. Senior Scientist. Directed event-driven field sampling program for St. Joseph River and provided guidance on development and application of mass balance models for coliform bacteria and dissolved oxygen.

Evaluation of Potential Impacts of Nitrogen Removal on Eutrophication in the Potomac Estuary. 1991-1993. Project Director. Conducted review of scientific literature, historical data and predictions of Potomac Eutrophication Model (PEM) to assess risk of proliferation of nitrogen-fixing blue-green algae under various point source nitrogen control strategies.

Lake Okeechobee Water Quality Modeling Evaluations. 1992. Project Director. Provided expert assistance in development and application of a water quality model for eutrophication in Lake Okeechobee, Florida.

Peer Review of Everglades Water Quality Research Plan. 1992. Senior Scientist. Provided external peer review of planning components for best management practices (BMPs) and development of watershed mass balance modeling tools for multi-objective management of water resources.

Development and Validation of an Integrated Exposure Model for Toxic Chemicals in Green Bay, Lake Michigan. 1988-1992. Principal Investigator. Developed and applied a suite of individual models to describe hydraulics, eutrophication, particle dynamics and toxic chemicals in the bay.

Development of Phase II Screening Model for TCDD (Dioxin) in the Columbia River. 1991-1992. Project Director. Application of a screening-level mass balance model to support development of a total maximum daily load (TMDL) for dioxin in the Upper and Lower Columbia, Snake and Willamette River Basins.

Evaluation of Potential Impacts on Juday Creek from Proposed Stormwater Detention Basins. 1991. Senior Scientist. Directed field monitoring, data synthesis and mass balance modeling of water and heat in the creek and proposed detention basins.

Expert Consulting and Review of Water Quality Modeling on Lake Mead, Nevada. 1990. Senior Scientist. Conducted peer review of water quality model for eutrophication in Lake Mead.

Toxics Modeling Workshops for Training EPA and State Regulatory Personnel. 1989. Principal lecturer on calibration of toxic chemical models at workshops in U.S. EPA Regions V (Chicago), IX (San Francisco), VIII (Boulder), IV (Atlanta) and X (Seattle), and for E.I. DuPont DeNemours and Company, Newark, Delaware.

Expert Consultant, U.S. Army Corps of Engineers. 1987. Provided expert assistance on selection of aquatic processes and state variables for a time-variable, three-dimensional water quality model of Chesapeake Bay.

Expert Consultant, Ontario Ministry of the Environment. 1987. Provided expert assistance on development of an aquatic food chain model to support the Ontario Municipal Industrial Strategy for Abatement.

Expert Consultant, Chesapeake Bay Program, U.S. EPA. 1984-1986. Provided technical assistance on planning and implementation of a water quality modeling program for nutrient enrichment and dissolved oxygen depletion in Chesapeake Bay.

Program Coordinator, Estuarine Research Program, Environmental Research Laboratory, Narragansett, U.S. EPA. 1984-1986. Conceived, planned and coordinated research in the areas of transport, fate and effects of contaminants and nutrients in estuarine and near-coastal environments.

Project Officer, U.S. Environmental Protection Agency. 1974-1986. Served as Project Officer on 12 research grants and cooperative agreements. Cumulative budgeted amount of this research was \$4 million. Results included publication of over 60 scientific papers and reports.

Lead Scientist, Office of Research and Development, U.S. EPA. 1984. Prepared and presented technical briefings on ocean disposal and estuarine research for the Consolidated Water Research Committee as part of the EPA research planning for fiscal years 1985 and 1986.

Program Coordinator, Ocean Disposal Research Program, Environmental Research Laboratory, Narragansett, U.S. EPA. 1983-1984. Conceived, planned and coordinated ocean disposal research in the areas of transport, transformation and fate of ocean-dumped contaminants.

Expert Consultant, Region I, U.S. EPA. 1982-1984. Provided technical assistance on physical transport and food chain modeling for PCBs and heavy metals in support of the New Bedford Harbor (Massachusetts) Superfund Project.

Expert Consultant, Office of Water Regulations and Standards, U.S. EPA. 1982-1983. Developed a scientific protocol for ocean dumpsite designation, and conducted a workshop consisting of scientific and technical experts to peer review the protocol.

Program Manager, Waste Load Allocation Program, Large Lakes Research Station, U.S. EPA. 1980-1981. Initiated studies in the Flint River (Michigan) watershed on the development and field application of waste load allocation models for heavy metals.

Visiting Scientist, International Institute for Applied Systems Analysis, Laxenburg, Austria. 1980. Applied water quality models to Lake Balaton (Hungary) under terms of an International Agreement between the Institute and the Hungarian Academy of Science.

Expert Consultant, National Aeronautics and Space Administration. 1979. Provided technical assistance on the applications of remote sensing imagery to water quality problems in lakes.

Expert Consultant, British Broadcasting Corporation-The Open University Centre. 1979. Provided technical assistance on the use of the Great Lakes as an international case study on phosphorus enrichment, and appeared in a film production entitled, "Inorganic Chemistry Concepts and Case Studies."

Expert Consultant, World Health Organization. 1978. Provided technical assistance on a water quality modeling project for the Billings Reservoir, Sao Paulo, Brazil.

Collaboration, International Institute for Applied Systems Analysis, Laxenburg, Austria. 1978. Transferred a water quality database for Saginaw Bay, Lake Huron, to the Institute for use in mathematical model intercomparisons.

Research Assistant, Department of Civil Engineering, University of Notre Dame. 1971-1972. Provided field sampling and laboratory analytical support for an EPA-sponsored project on Stone Lake, Michigan. Provided technical support and data analysis for an advanced wastewater treatment project sponsored by Telecommunications Industries, Inc., Copiague, Long Island.

Teaching Assistant, Department of Civil Engineering, University of Notre Dame. 1971. Taught an undergraduate laboratory course in air pollution. Constructed a monodisperse aerosol generator and various air sampling devices.

Research Assistant, Department of Physics, University of Notre Dame. 1969. Constructed and tested electronic instrumentation and field-mapped a large bending magnet in support of an NSF-sponsored high-energy physics project at Argonne National Laboratory.

Teaching Assistant, Department of Physics, University of Notre Dame. 1968-1969. Taught undergraduate laboratory courses and tutorial classes.

Science Teacher, Northeast Catholic High School, Philadelphia, Pennsylvania. 1966-1968. Taught lecture and laboratory courses in Physics (11th Grade) and Introductory Physical Science (9th Grade).

Selected Publications

Journal Articles

Predicted Impacts from Offshore Produced Water Discharges on Hypoxia in the Gulf of Mexico. Bierman, V.J., Jr., S.C. Hinz, D. Justić, D. Scavia, J.A. Veil, K. Satterlee III, M.E. Parker and S. Wilson. Society of Petroleum Engineers Projects, Facilities & Construction. 3(2):1-10. 2008.

Forecasting Gulf's Hypoxia: The Next 50 Years? D. Justić, V.J. Bierman, Jr., D. Scavia and R. Hetland. Estuaries and Coasts. 30(5):791-801. 2007.

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The Lake Okeechobee Water Quality Model (LOWQM): Enhancements, Calibration, Validation and Analysis. R.T. James, V.J. Bierman, Jr., M.J. Erickson and S.C. Hinz. Lake and Reservoir Management. 21(3):231-260. 2005.

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Predicted Impacts from Offshore Produced Water Discharges on Hypoxia in the Gulf of Mexico. Prepared for U.S. EPA, Region 6, Dallas, Texas. EPA Contract No. 68-C-03-041. 2006.

Summary of Water Quality Models for Hypoxia in the Gulf of Mexico. Prepared for Offshore Operators Committee, New Orleans, Louisiana. 2004.

Chesapeake Bay Water Quality Model: Summary of Technical Support on Model Calibration and Load Allocations. Prepared for Metropolitan Washington Council of Governments, Washington, D.C. 2003.

Water Quality Assessment for Reissuance of NPDES Permit. Prepared for Smithfield Packing Company, Inc., Tar Heel, North Carolina. 2001.

Ecosystem Model for the Lake Michigan Mass Balance Study. Final Technical Report, U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, Illinois. Contract No. 68-R7-5003/0002. 2000.

Revised Baseline Modeling Report, Volume 2D, Books 1 and 2, Hudson River PCBs Reassessment RI/FS. U.S. Environmental Protection Agency, Region II, and U.S. Army Corps of Engineers, Kansas City District. 2000.

Everglades Water Quality Model Calibration Report. Prepared for South Florida Water Management District, West Palm Beach, Florida. 1997.

Application of a Coupled Primary Productivity-Exotic Species Model for Saginaw Bay, Lake Huron. U.S. Environmental Protection Agency, Large Lakes Research Station, Grosse Ile, Michigan. 1997.

Estimated Responses of Water Quality on the Louisiana Inner Shelf to Nutrient Load Reductions in the Mississippi and Atchafalaya Rivers. U.S. Environmental Protection Agency, Gulf of Mexico Program Office, Stennis Space Center, Mississippi. 1995.

A Preliminary Ecosystem Modeling Study of Zebra Mussels (*Dreissena Polymorpha*) in Saginaw Bay, Lake Huron. U.S. Environmental Protection Agency, Large Lakes and Rivers Research Branch, Grosse Ile, Michigan. 1995.

Preliminary Assessment of Nitrogen Impacts on the Lake Okeechobee Ecosystem. Prepared for the South Florida Water Management District, West Palm Beach, Florida. 1993.

Evaluation of Nitrogen Removal Eutrophication Risk for the Freshwater Potomac Estuary. Prepared for Metropolitan Washington Council of Governments, Washington, D.C. 1993.

Phase II Screening Model Application to Dioxin (2,3,7,8-TCDD) in the Columbia River. Prepared for the U.S. Environmental Protection Agency, Region X, Seattle, Washington. 1992.

Screening Level Analysis for Estimation of Sediment Quality Criteria Impacts. Prepared for the Office of Wastewater Enforcement and Compliance, U.S. Environmental Protection Agency, Washington, D.C. 1992.

Awards

James R. Rumsey Award, Michigan Water Environment Association, 1995.

Monetary Awards for Special Achievement, U.S. Environmental Protection Agency, 1981; 1982; 1983; 1984.

Monetary Awards for Scientific and Technical Achievement, U.S. Environmental Protection Agency, 1981; 1982; 1983.

Bronze Medal, U.S. Environmental Protection Agency, 1978.

Quality-Step Merit Award, U.S. Environmental Protection Agency, 1976.

National Wildlife Federation Fellowship, 1972.

National Science Foundation Traineeship, 1969.

Specialized Training and Coursework

Institute on Mathematical Modeling of Water Quality, Manhattan College, New York, 1985.

APPENDIX B

ANALYSIS OF GLEAMS MODEL INPUT FILES

Summaries of Dr. Engel's Plant Nutrient Parameter Input Files for Pasture Land Use Table B-1.

Expert Report of Victor J. Bierman, Jr.

1) GLEAMS original (initial) parameter input values were extracted from the 1N*, PAR files and 2NP, PAR files located in the following directories:

"N:URWLAW1 Expert_Reports/Engel Materials/Gleans_Final/1.1.FUTURE_100YRULLINOIS/ORGINPUT

"N:URWLAW1Exper_Reports|Engel!Materials|Gleams_Final\1.1.FUTURE_100YR\BARRONFORF\OriginInpm

"N:URWLAW1/Expert_Reports|Engel)Materials|Gleams_Final\11.1.FUTURE_100YR\CANEYCREEK\OriginInput

2) GLEAMS cationated (final) parameter input values were extracted from the 1N*, PAR files located in the ILLINOIS, BARRONFORT, and CANEYCREEK sub-fielders:

3) Knizel, W.G. and Davis, F.M. 2000. GLEAMS (Groundwater Loading Effects of Agricultural Management Systems), Version 3.0, User Manual. Pub. No. SEWRL-WGK/FMD-030199, "N: IRWLAWI Expert_Reports!Engel!Materials!Gleams_Final\1.1.FUTURE_100YR*"

4) "Expert Report" refers in "Poultry Waste Generation and Land Application in the Illinais River Wotershed and Phosphorus Loads to the Illinais River Watershed Streams and Rivers and

Lake Tenkikir, Expert Report of Dr. B. Engel, For State of Oklahoma, In Case No. 05-CU-329-GKF-5841, State of Oklahoma v. Tyson Foods, et al. (In the United States District Court for the

5) E-mail corresymodence an Wednesday, August 13, 2008 8:27 AM: From David Page; To Robert George, Louis Bullock, David Riggs, Elizabeth Claire Xidis; Northern District of Oklahoma), Dr. B. Engel, P.E. Professor of Agricultural and Biological Engineering, May 22,2008"

Subject, RE: Follow Up Items from July 11 Teleconference with Dr. Engel.

6) Parameter input value ranges set for the automated calditration procedure via the Shaffled Camplex Evolution Algorithm (SCE-UA) were extracted from the "SCE-DAT" file in the 1LLNOIS BARRONFORT, and CANEYCREEK sub-folders in the following directory: "N/IRWLAWI/Expert_Reports/Engel/Materials/Gleums_Final\1.1.FUTURE_100fR*"

Plant Nutrient Parameter Input File for Pasture Land Use (INP.PAR, 2NP.PAR)

wof Original (Initial) Parameter Innut Values and Calibrated (Final) Parameter Innut Values

Samme	Summary of Original (Trinda) & arameter righal 7 and Sum Cantorials & arange tright a manager right and	nder in	T tetters into	THE CHILD HIS	n r (1991) r n	Turing Timb	Canan In				
Parameter	Parameter	Unit	Alla Ris MoZ)	Illinois River (Zone 2)	Illinois River (Zone 3) †	nois er .3) ⁷	B.	Baron Fork	Caney	iej ek	Comment
Name	Description		Original Innet Value	Calibrated Innut Value	Original Input Value	Calibrated Innut Value	Original Input Value	Original Calibrated	Original Calibrated Input Value Input Value	Calibrated Input Value	
МОК	Organic matter contem in animal waste.	%	69.5	5.99	5'69	69.5	21.0	21.0	21.0	21.0	All sub-basin parameter input values were calibrated and constrained between 0.12 and 86.9 using an automated calibration.
APHOS	Total phosphorus content in animal waste.	% ''a	1.70	1.70	1.70	1.70	2.35	2.35	2.35	2.35	All sub-basin parameter input values were calibrated and constrained between 1.664 and 2.496 using an automated ealthration.
APORGP	Organic phosphorus content in animal waste.	%	0.95	56:0	56:0	6.95	76:0	26'0	26'0	26'0	All sub-basin parameter input values were calibrated and constrained between 0.95 and 0.99 using an automated calibration.
	Labile phosphorus concentration in each		71.9	61.7	133.2	114.2	138.6	61.9	52.8	40.0 33.8	Parameter inputs are listed one to five for each soil horizon. Illinois River parameter input values were calibrated and constrained between 100 and following an automated calibration.
CLAB()	soil horizon. (Number of soil horizons ≈ 5)	a/dn	68.2 47.5 43.7	45.5 40.7 37.5	88.0 80.9	84.3 75.4 69.4	126.4 126.4 119.9	45.7 40.9 37.6	49.7 48.3 45.5	29.5 26.4 24.3	Baron Forwand Carley Creek paraflacer right values canon act and usus an act and sold all sub-basin labile phosphoras upus values were manually modified after the automated calibration.
ЭE	Date of fertilizer application, year of the crop rotation and Julian day.	No Units	1077	1066	1017	1066	1099	1077	1037	1077	Illinois River parameter input values were calibrated and constrained between 60.0 and 300 Using an automated calibration. Baron Fork and Caney Creek parameter input values were calibrated and constrained between 100 and 120 using an automated calibration.
RATE	Application rate for animal waste.	tn/ha	69:0	0.50	1.29	0.93	1.04	0.59	0.10	0.10	All sub-basin parameter input values were calibrated and constrained between 0.10 and 1.20 using an automated calibration.
RESDW	Crop residue on the ground surface when simulation begins.	kg/ha	3258.6	3258.6	3258.6	3258.6	4362.3	4362.3	62.3	62.3	All sub-basin parameter input values were catibrated and constrained between 0 and 7,000 using an automated calibration.

Abbreviations:

F S

GLEAMS default parameter value applied. This parameter input value was not calibrated for this particular land use.

Generic or example value from p.191 of the GLEAMS user manual applied unless noted otherwise. This parameter input value was not calibrated for this particular land use. Not applicable. Parameter input value may not be required if certain model atributes are not selected. For example, parameter inputs required for fertilizer application

would not be required if a particular land use or field is not fenilized

The Himois River sub-basin is comprised of nutrient loading Zone 2 and Zone 3 (see p. D-17 of Engel's Expert Report). There are separate pasture nutrient input files for Zone 2 and Zone 3.

The LNP.PAR nutrient input file is specified for Zone 2 and the 2NP.PAR file is specified for Zone 3.

Summary of Dr. Engel's Plant Nutrient Parameter Input File for Crop Land Use Table B-2.

Sources of information:

Expert Report of Victor J. Bierman, Jr.

1) GLEAMS original (initial) parameter input values were extracted from the 1N* PAR files located in the following directories:

"N: URWLAWI Expert_Reports | Engel Materials | Gleans_Final | I.FUTURE_100YR/ILLINOIS | ORGINPUT

"N: URWLAWI\Expert_Reports\Engel\Materials\Gleams_Final\!I.I.FUTURE_100YR\BARRONFORT\OriginInput

"N:URWLAW1)Expert_Reports\Engel\Materials\Gleams_Final\1.1.FUTURE_100YR\CANEYCREEK\OriginInput

2) GLEANS calibrated (final) parameter input values were extracted from the 1N* PAR files located in the ILINOIS, BARRONFORT, and CANEYCREEK sub-folders:

3) Knisel, W.G. and Davis, F.M. 2000, GLEAMS (Groumdwater Loading Effects of Agricultural Management Systems), Version 3.0, User Manual. Pub. No. SEWRL-WGK/FMD-050199. "N:URWLAW1\Expert_Reports\Engel\Materials\Gleams_Final\1.1.FUTURE_100YR*"

Lake Tenkiller, Expert Report of Dr. B. Engel, For State of Okluhoma, In Case No. 03-CU-329-GKF-SAJ, State of Okluhoma v. Tyson Foods, et al. (In the United States District Court for the 4) "Expert Report" refers to "Poultry Waxte Generation and Land Application in the Illinois River Watershed and Phosphorus Loads to the Illinois River Watershed Streams and Rivers and

S) E-mail correspondence on Wednesday, August 13, 2008 8:27 AM; From David Page; To Robert George, Louis Bullock, David Riggs, Elizabeth Claire Xidis: Northern District of Oklahoma), Dr. B. Engel, P.E. Professor of Agricultural and Biological Engineering, May 22,2008"

Subject, RE: Follow Up Items from July 11 Teleconference with Dr. Engel.

Plant Nutrient Parameter Input File for Crop Land Use (INC.PAR)

Summa	Summary of Original (Initial) Parameter Input Values and Calibrated (Final) Parameter Input Values	er Inpu	t Values an	d Calibrate	d (Final) F	arameter l	nput Value	S	
Parameter	Parameter	į	Illinoi River	Illinois River	Ba Fe	Baron Fork	Caney Creek	iey ek	Comment
Name	Description	<u> </u>	Original Input Value	Calibrated Input Value	Original Input Value		Calibrated Original Calibrated Input Value	Calibrated Input Value	
МОК	Organic matter content in animal waste.	%	86.0 86.0	86.0 86.0	86.0 86.0	86.0 86.0	86.0 86.0	86.0 86.0	There are two fertilizer applications of animal waste, which requires two separate parameter input values.
APHOS	Total phosphorus content in animal waste.	%	0.82 0.82	0.82	0.82 0.82	0.82 0.82	0.82 0.82	0.82 0.82	There are two fertilizer applications of animal waste, which requires two separate parameter input values.
APORGP	Organic phosphorus content in animal waste.	%	0.79 0.79	0.79 0.79	0.79 0.79	0,79 0.79	0.79 0.79	97.0 97.0	There are two fertilizer applications of animal waste, which requires two separate parameter input values.
CLAB()	Labile phosphorus concentration in each soil horizon. (Number of soil horizons = 5)	8/8n	09	09	80	80	09	09	CLAB input values are the same for all soil horizons.
DF	Date of fertilizer application, year of the crop rotation and Julian day.	No Units	1091 1140 2100	1091 1140 2100	1091 1140 2100	1091 1140 2100	1091 1140 2100	1091 1140 2100	There are three fertilizer applications, which requires three separate parameter input values. Two fertilizer applications consist of animal waste and one fertilizer application consists of inorganic commerical fertilizer.
RATE	Application rate for animal waste.	tm/ha	5.00 3.00	5.00 3.00	5.00 3.00	5.00 3.00	5.00 3.00	5.00 3.00	There are two fertilizer applications of animal waste, which requires two separate parameter input values.
RESDW	Crop residue on the ground surface when simulation begins.	kg/ha	DF	DF	DF	DF	DF	DF	

Abbreviations:

N SN DF

GLEAMS default parameter value applied. This parameter input value was not calibrated for this particular land use.

Generic or example value from p.191 of the GLEAMS user manual applied unless noted otherwise. This parameter input value was not calibrated for this particular land use. Not applicable. Parameter input value may not be required if certain model attributes are not selected. For example, parameter input sequired for fertilizer application

would not be required if a particular land use or field is not fertilized.

Summary of Dr. Engel's Plant Nutrient Parameter Input File for Forest Land Use Table B-3.

Sources of information:

Expert Report of Victor J. Bierman, Jr.

1) GLEAMS original (initial) parameter input values were extracted from the 1N*. PAR files located in the following directories:

"N:URWLAW1Expert_Reports/Engel/Materials/Gleans_Final/1.1.FUTURE_100YRULLINOIS/ORGINPUT

"N:IIRWLAWI\Expert_Reports\Engel\Materials\Gleams_Final\L.I.FUTURE_100YR\BARRONFORT\OriginInput

"N:IRWLAWI\Exper_Reports\Engel\Materials\Gleams_Final\!!.I.FUTURE_100YR\CANEYCREEK\OriginInput

2) GLEAMS calibrated (final) parameter input values were extracted from the 1N* PAR files located in the ILLINOIS, BARRONFORT, and CANEYCREEK sub-folders:

"N:URWLAWI)Expert_Reports\Engel\Materials\Gleams_Final\1.1.FUTURE_100YR*"

3) Knisel, W.G. and Davis, F.M. 2000. GLEAMS (Groundwater Loading Effects of Agricaltural Management Systems), Version 3.0, User Manual. Pub. No. SEWRL-WGKFMD-030199.

Lake Tenkiller, Expert Report of Dr. B. Engel, For State of Oklahoma, In Case No. 05-CU-329-GKF-SAJ, State of Oklahoma v. Tyson Foods, et al. (In the United States District Court for the 4) "Expert Report" refers to "Poultry Waste Generation and Land Application in the Illinois River Watershed and Phosphorus Loads to the Illinois River Watershed Streams and Rivers and

5) E-mail correspondence on Wednesday, August 13, 2008 8.27 AM, From David Page: To Robert George. Louis Bullack, David Riggs, Elizabeth Claire Xidis: Northern District of Oklahoma), Dr. B. Engel, P.E. Professor of Agricultural and Biological Engineering, May 22,2008"

Subject, RE: Follow Up Items from July 11 Teleconference with Dr. Engel.

Plant Nutrient Parameter Input File for Forest Land Use (INF.PAR)

Summary of Original (Initial) Parameter Innut Values and Calibrated (Final) Parameter Innut Values

Summa	Summary of Original (Initial) Farameter Input Values and Calibrated (Final) Farameter Input Values	ter Inpu	t values an	a Calibrate	a (rimai) r	arameter 1	npui vaiue	×	
Parameter	Parameter	1	Illia Riv	Illinais River	Ba	Baron Fork	Caney Creek	ey ek	Comment
Name	Description		Original Input Value	Original Calibrated Input Value Input Value	Original Input Value	Original Calibrated Original Calibrated Input Value Input Value Input Value	Original Input Value	Calibrated Input Value	Contract
MON	Organic matter content in animal waste.	9%	NA	NA	NA	NA	NA	NA	
APHOS	Total phosphorus content in animal waste.	%	NA	NA	NA	NA	NA	NA	
APORGP	Organic phosphorus content in animal waste.	9/6	NA	NA	NA	NA	NA	NA	
CLAB0	Labile phosphorus concentration in each soil horizon. (Number of soil horizons = 5)	ā/ān	10	20	30	20	10	25	CLAB input values are the same for all soil horizons. Labile phosphorus input values were manually modified during the calibration process.
DF	Date of fertilizer application, year of the crop rotation and Julian day.	No Units	NA	NA	NA	NA	NA	ΝΑ	
RATE	Application rate for animal waste.	tn/ha	NA	NA	NA	NA	NA	NA	
RESDW	Crop residue on the ground surface when simulation begins.	kg/ha	DF	DF	DF	DF	DF	DF	

Abbreviations:

GLEAMS default parameter value applied. This parameter input value was not calibrated for this particular land use. DF GN NA

Generic or example value from p. 191 of the GLEAMS user manual applied unless noted otherwise. This parameter input value was not calibrated for this particular land use.

Not applicable. Parameter input value may not be required if certain model attributes are not selected. For example, parameter inputs required for fertilizer application

would not be required if a particular land use or field is not fertilized.

Summary of Dr. Engel's Plant Nutrient Parameter Input File for Urban Land Use Table B-4.

Sources of information:

Expert Report of Victor J. Bierman, Jr.

l) GLEAMS original (initial) parameter input values were extracted from the 1N* PAR files located in the following directories:

"N: JIRWI.AWI Expert_Reports\Engel\Materials\Gleams_Final\1.1.FUTURE_100YR\ULL\NOIS\ORGINPUT

"N: IIRWLAWI Expert Reports Engel Materials Gleons Final I.I. FUTURE 100 YR BARRON FORT Origin Input

N: JRW LAW I Expert Reports Engels Materials (Gleams_Final). J. F. OTORE_TOOTRES AAAOAT OAT OT Rymnipu "N: JRW LEXPERT_Reports: Engels Materials (Gleams_Final). J. FUTURE_1007R (CANEYCREEK) OriginInput

2) GLEAMS calibrated (final) parameter input volues were extracted from the 1N* PAR files located in the ILLINOIS, BARRONFORT, and CANEYCREEK sub-folders:

"N: URWLAWI\Expert_Reports\Engel\Materials\Gleams_Final\]1.FUTURE_100YR*"

3) Knisel W.G. and Davis, F.M. 2000, GLEAMS (Groundwater Loading Effects of Agricultural Management Systems), Version 3.0, User Manual. Pub. No. SEWRL-WGKFMD-050199,

Lake Tenkilter, Expert Report of Dr. B. Engel, For State of Oklahama, In Case No. 03-CU-329-GKF-SAJ, State of Oklahama v. Tyson Foods, et al. (In the United States District Court for the 4) "Expert Report" refers to "Poultry Waste Generation and Land Application in the Illinois River Watershed and Phosphorus Loads to the Illinois River Watershed Streams and Rivers and

5) E-mail correspondence on Wednesday, August 13, 2008 8:27 AM, From David Page: To Robert George, Louis Bullock, David Riggs, Elizabeth Claire Xidis: Northern District of Oklahoma), Dr. B. Engel, P.E. Professor of Agricultural and Biological Engineering, May 22,2008"

Subject, RE: Follow Up Items from July 11 Teleconference with Dr. Engel.

Plant Nutrient Parameter Input File for Urban Land Use (INU.PAR)

motor Innut Values and Calibrated (Final) Parameter Innut Values

Summa	Summary of Original (Initial) Farameter Input Values and Calibrated (Final) Farameter Input Values	ter inpu	t vatues an	ia Cauoraie	a (rinai) r	arameter 1	прии у ание	c	
Parameter	Parameter	T. C. L.	IIIII Rt	Illinois River	Ba Fe	Baron Fork	88	Caney Creek	
Name	Description	Com	Original Input Value	Calibrated Input Value	Original Input Value	Original Calibrated Original Calibrated Input Value Input Value Input Value	Original Input Value	Calibrated Input Value	
40M	Organic matter content in animal waste.	%	NA	NA	NA	NA	NA	NA	
APHOS	Total phosphorus content in animal waste.	%	NA	NA	NA	NA	NA	NA	
APORGP	Organic phosphorus content in animal waste.	%	NA	NA	NA	NA	NA	NA	
CLAB0	Labile phosphorus concentration in each soil horizon. (Number of soil horizons = 5)	g/gn	DF	DF	DF	DF	DF	DF	
DF	Date of fertilizer application, year of the crop rotation and Julian day.	No Units	NA	NA	NA	VN	NA	NA	
RATE	Application rate for animal waste.	tn/ha	NA	NA	NA	NA	NA	NA	
RESDW	Crop residue on the ground surface when simulation begins.	kg/ha	DF	DF	DF	ÐF	ЭG	DF	

Abbreviations:

N S

GLEAMS default parameter value applied. This parameter input value was not calibrated for this particular land use.

Generic or example value from p.191 of the GLEAMS user manual applied unless noted otherwise. This parameter input value was not calibrated for this particular land use. Not applicable. Parameter input value may not be required if certain model attributes are not selected. For example, parameter inputs required for fertilizer application

would not be required if a particular land use or field is not fertilized.

Table B-5. Dr. Engel's Plant Nutrient Parameter Input Files for Pasture Land Use

Sources of Information:

1) GLEASE parameter injust values were extracted from the 1N° PAE files and 2NP PAE files located in the ELLINGIS, BARRONFORT, and CAREYCREEK stop-folders in the following directors: "N° URELATE Expert Pages of the 1N° PAE files and 2NP PAE files located in the ELLINGIS, BARRONFORT, and CAREYCREEK stop-folders in the following directors: "N° URELATE Expert Pages of the 1N° PAE files to the 1N° PAE files and 1N° PAE files to 1N° PAE files files files to 1N° PAE files files to 1N° PAE files files files to 1N° PAE files files to 1N° PAE files fil

Plant Nutrient Parameter Input File for Pasture Land Use (INP.PAR. 2NP.PAR)

Plant Ni	itrient Pa	rameter Input File for Pasture Land Use	(INP.PA	R, 2NP.1					
					Parson. Valu	eter v			
Card 4	Parameter Name	Parameter	Unia	Illinois	Hitters	*		Source of Purameter	Comment
	Name	Description		River	River	Baron Fork	Citney Creek	Value	
		Three 80-character lines of alphamoneric information that		(Zone 2)	(Zone 3)				
ы	ritie	identifier the particular computer run. For example, the soil type, the crop rotation, the ullage practices, may be useful in identifying	No Coits					GN	The run description does not provide any information regarding the tite-specific opplication to the JRW. The run description is a generic description that was taken from an example input file on p. 189 of the GLEAMS user manual.
	NATE	the frie and specific GLEAMS application. Beginning year of place patricul simulation.	Your	1901	1901	1901	1901	AS	
7	NEYR	Ending year of plant marient simulation.	Year	2000	2000	3000	2000	AS	
-	NUTOUT	Code to designate level of printed marient output	No Units	2	2	2	2	AS	
	FLGROT	Number of years in a crop rotation cycle. Code for comput of N and P balance at the end each year of	No Units		!	!		AS	
	FLGBAE	simulation.	No Unite	- 0	0	0	0	AS	
5	RESDR	Crop residue on the ground surface when simulation begins.	kg/ha	1258.6	3258.6	4362.3	62.7	CAL	All cub-basin parameter input values were calibrated and constrained between 0 and 7,00% of ing an entopasted calibration.
	RCN	Nitrogen concentration in rainfatt	ppm	0.8	0.8	0.8	9.8	72N	
3	CM CPI	Concentration of intrate-nitrogen in irrigation. Concentrative of labife-phosphorus in irrigation.	ppro					DF DF	
			12.0	8.055	0.055	0.055	0.055		
•	IN 0	Tistal nitrogen in each soil borizon. (Number of soil borizons ~ S)	*	8.055 8.043 6.943 (7.62)	0.055 0.043 0.041 0.021	0.055 0.043 0.043 0.021	0.055 0.043 0.643 0.021	GN	Parameter inputs are listed one to tive for each soil horizon.
7	CNITO	Nitrate-nitragen concountstion in each soil horizon. (Number of soil horizons = 5)	ag'g	10 10 7.8 7.8 3.0	10 10 7.0 7.0 3.0	10 10 7.0 7.0 3.0	10 10 7.0 7.0 3.6	GN	Parameter suppos are listed one to five for each soil boxizon.
,	POTMNI)	Potentially mineralizable miragen in each soil borizon. (Number of soil borizons + 5)	kg/ha	150.0 150.0 230.0 230.0 115.0	150.0 150.0 230.0 230.0 (15.0	150.0 150.0 230.0 239.6 115.0	150.0 150.0 230.0 230.0 115.0	GN	Parameter imputs are listed one to five for each soil horizon.
9	ORGNW	Organic nitrogen content from animal waste in the plow	%	- 6	0	- 6	0	GN	
10	TPO	horizon. Total phosphorus in each soil horizon.	**			t	l	DE	
<u> </u>	11.0	(Namber of so0 hor(zons= 5)			 			L	Parameter imputs are listed one to Gyo for each soit horizon.
"	CLABO	Labile phosphorus concentration in each soil horizon. (Number of soil horizons = 3)	og/g	61.7 52.1 45.5 40.7 37.5	114.2 96.5 84.3 75.4 69.4	61.9 52.3 45.7 40.9 37.6	40.0 33.8 29.5 26.4 24.3	CAŁ.	Hinois River parameter input values were collected and constrained between 100 and 300 strained and constrained between 100 and 300 strained and constrained between 500 and 100 strained and constrained between 500 and 150 warge on constrained subheration. All sub-basin labels phosphorus input values were manually modified after the extension of the properties of althretion.
12	ORGEW	Organic P content from minual waste in plow horizon.	%	0	- 6	0	0	GN	
		Due that the following parameters are valid, year of the							
13	PDATE	crop rotation cycle and fulian day.	No Units	1003	1001	1001	1003	AS	
14	NF	Number of jettilizer and animal waste applications during the update period.	No Units	,	1	,		AS	
14	NTIL	Number of fillage operations during the update period.	No Mnits	0	0	0	0	AS	
14	DIIRVST	Date of evop barvest, year of the crop rotation cycle and	No Units	1310	(310	1310	1316	SS	
14	DIIKYSI	Julian day.	No Celts	1310	1,110	1376	1316	23	
15	ICROP	Identification oursier of the crop grown during this cropping period.	No Units	Z	2	2	2	22	Alfalfa-hay is the crop type specified.
15	LEG	Code for legume crap.	No Units	0	0	0	0	DF	
15	PY	Potential yield for the harvestable portion of the srap.	kg/hs	4500	4500	4500	4508	DF	
15	DMT	Dry matter ratio, the ratio of total dry matter production to	No Umin	•		1		DF	
15	CNR	harvestable portion of the crop.	No Units					DF	·
15	ANP	Carbon nitrogen ratio for the crop. Ratio of crop nitrogen to phosphorus.	Na Units		†	·····		DF	
15	CI	Coefficient in the exponential relation to extensite nitrogen	No Units					DF	
15	G	content of the crop. Exponent in the exponential relation to estimate nitrogen	No Units	-	-	 		DF	
16	DF	content of the erop. Date of fertilizer application, year of the crop rotation and fulian stay.	No Units	1066	1066	1077	1077	CAL	Illinois River parameter input values were calibrated and constrained between 60.0 and 300 roing an automated calibration. Baron Fork and Caney Cycel parameter input values were calibrated and constrained between 500 and 120 using an automated calibration.
16	MFERT	Code for method of fertilization.	No Units	,	,	,	,	AS	Code ~ 1 indicates that an organic (animal weste or sewage sludge) is applied.
16	METHAP	Code for rootbod of application.	No Units	- 0	0	0	0	AS	Code = 0 denotes surface application of tentilizer or animal waste.
/d	MTYPE	Code for animal waste type.	No Units	15	15	15	15	AS	Code = 15 indicates that the user specifies total N and P, organis N and P, ammonis and soluble phosphorus is animal waste.
17	FN	Fertilizer nitrate	kg/ha		ļ	1	1	NA	Card 17 is skipped if animal wante is applied.
17	FNH FF	Fertilizer ammonia. Fertilizer phosphorus.	kg/ha kg/ha	 	 	 	 	NA NA	Card 17 is skipped if animal waste is applied. Card 17 is skipped if animal waste is applied.
17	DEPIN	Depth of incorporation.	cma					NA.	Card 17 is skipped if animal waste is applied.
17	FRTWAT	Depth of water applied for fertigation.	стра	 	-	ļ	 	NA.	Card 17 it shipped if animal waste is applied. All sub-basin parameter input values were calibrated and constrained between 0.10 and
18	RATE	Application rate for animal waste.	trs/ha	0.5b	0.93	0.59	(7.3	CAL	(.20 using an automated calibration.
18	DEPIN ATN	Depth of incorporation. Total narragen in spirmal waste.	cro 5/4	2.81	2.81	2.81	2.81	GN /3N	
18	APORGN	Organic mitrogen content in animal westr.	%	2.08	2.08	2.08	2.08	GN	
18	ANH	Ammonia content to animal waste.	%	0.72	0.72	0.72	0.72	GN	
18	APHOS	Total phosphorus content in animal waste.	%	1.70	1.79	2.35	2.35	CAU	All sub-basin parameter input values were calibrated and constrained between 1.664 and 2.496 using an estomasted calibration.
18	APORGP	Organic phosphorus content in animal waste.	%	0.95	0.95	0.97	0.97	CAL	All sub-basin parameter input values were calibrated and constrained between 0.95 and 0.99 using an automated calibration.
14	AOM	Organic matter content in animal waste.	1/6	69.5	69.5	21.0	21.0	CAL	All sub-basin parameter input values were calibrated and constrained between 0.12 and 86.0 using an outomated calibration.
18	WASTYP	Type of an must waste je.g., solid, skirry, or liquid).	Nor Units	-)	-		AS	Code = 1 denotes that waste is in solid form.
19	NTDAY	Date of tillage, year of crop rotation cycle and Julian day.	No Units	ļ		 		NA.	
19	I.TIL DIII.	Code to designate the tillage implement or equipment ased. Depth of tillage.	No Units		ļ	 	ļ	NA NA	
19	EFFINC	Efficiency of incorporation of surface residue.	No Ogits		L			NA	
19	FMIX	Tillage maxing efficiency.	No Units	1		1	1	NA.	

Application specific postneter value applied to set simulation time periode, output perferences, and parameter codes for particular method applications (e.g., method of Testilizasion).
CLEARS selected parameter value applied.
Cabbristo personner value applied.
Cabbristo personner value applied.
Cabbristo personner value applied.
Cabbristo personner value applied.
Not applicable. Personner input value from p. 189 of the CLEARS are manual applied unless noted extensive.
Not applicable. Personner input value from p. 189 of the may not be required if certain model students are not selected. For example, parameter imputs required for festilized application would not be required if a personner value applied.
Selected in the required real particular hand use or ided it not fertilized.

The //lianis River sub-basin is comprised of numero loading Zone 2 and Zone 3 (see p. D-17 of Engel's Expert Report). There are separate pasture nutrient input files for Zone 2 and doe 2 NP PAR file is specified for Zone 2.

Table B-6. Dr. Engel's Plant Nutrient Parameter Input File for Crop Land Use

Savetes of information:

10 (1941) And present open visuals are advandables to 10 fell flat located in the EDNO. EMBORIOSE and CARTISEES will below
to the Scholar photose. In 18 (1947) Agree information and the EDNO. EMBORIOSE (1982)

10 (1944) And CARTISEES will be a served in the CARTISEES of the CARTISEES will be a served in the CARTISEES of the CARTISEES of the CARTISEES will be a served in the CARTISEES will be a served in the CARTISEES of the CARTISEES of the CARTISEES will be a served in the CARTISEES of the CARTISEES of

		amoter found fills for Creek Land Her (IN)	CDARL					
Contail	1000	ometer Input File for Crop Land Use (IN			Parameter			
10000000	Parameter Vano	Parameter Description	2500	Discour	Value Raren	Coney	Source of Parameters Value	Comment
		There 60 character lines of sightenumeric information des		Rices	F-et	Lores	1.000	
14	nnx		No Craize				GN	Fire now descriptions does not provide any information regarding the vite report to application to the BCW. The run description is a generic description than one values from an example input file on 1 169 of the CLEANSS area material.
~	//···	type, the crop cotation, the tilings practices, may be useful in identifying the fite and specific 13, 13, 13, 44 application.	NO COLINA					an example input file on 1 169 of the GLEAMS are respond
7	NETE		Yes	1991	1901	1901	A5	
	NETA. NUTUUT	Disting West of plant metrical street blood. Code to designate level of printed a opical otapes.	Year No Esta	2000	2000	2000	AS AS	
	11.52	Number of veers in a same motories contr. Code for output of N and P belance at the code cach year of	No links		L		A5	
	FEIZEAL.	Amadeside.	No Haire	٥		9	AS	
1	RESIM	Crop realister by the ground surface when simulation begins	kgriss				194	
1	ENI CNI	Nicongen concentration is sainfall. Concentration of hitrary nitrigens in irrigation.	ppm				DF D/	-
	SPI.	Concentration of sitrage allowant is irregistion. Concentration of lability place; because in tragation. Total stronger in each only because. (Youthern of seigh labilities = 5) Németer also concentration in create soil because. (Opender of seigh labilities on create soil because.	ppes				1#	
•	EN0	(Number of soj) boritour = 5)	٠,			-	104	
,	CNITO	(Paraba of sail torizons = 5)	ونون				199	
,	POTMING	Potentially assertalization strugges in each soil territors (Nomitor of soil territors = 5)	14/14				DV	
	OFGER.	Occasio distance control Acre below bears in the name	- 14				195	
,	- Caranta	Total shortherns in much and business						
14	FPU	(Negotiar of pull horrigoger 1)	%				t)#	
0	recent,	table phosphorus concentration is each soil for box. (Penther of soil beatsons = 2)	19/A	w	80	60	CAL	CLAS deput values are the same for all null nurinous. Cabile phosphares layer values were manually modified deploy the calibration process.
 ,,	OFGER	Organic P collect from mirral want in plow horizon.					56	
0.000	HOUSE CO.	Aren a secure	4/					of the Artist and the
",	PD-178	Date that the following parameters are valid, year of the crop roution cycle and falling day	Na Date	[00]	1003	1001	(7N	
		crop routine cycle and falling day. Number of Services and animal France applications during.						
7*	NF.	the applied persons	No Here	1	'	1	NU	
14	NTA	Number of tilinge operations during the apdate period.	No Chico		. (1	nn .	
14	DHR:ST	Date of crop kervers, year of the crop rotation cycle and Julius day	No Dante	1344	1274	1743	@v	
15	(Chip	Identification member of the crieg grown during this	No Units	31	20	200	ON.	Consignain is the crop type specified.
. 13	149	Grospine period. Code for largement grop.	No Units				DF	
15	er	Potential sink for the betweenhold postions of the camp	rg ha				DF	
0	לאמ	Dry seaties ratio, the ratio of worl dry market presturnion to have emble portion of the cross.	No Utilu				DF	
15	CNA RNF	havenights purion of the city. If after agreement for the city. Ratio of crop stranger to pleophorus Ratio of crop stranger to pleophorus Coefficient to the exponential relation to changes alreague	No histo No Listo				DÆ.	
13	CI	e oefficient (e the exponential teletion to extense astrogra-	No Chica		_		DF DF	
100	0	content of the prop. Exponent in the exponential relation to entiresse still again.	No Units				DE	
	···	content of the care.	CO CHIL		-		NT.	There are two fertilizer applications of animal warte. The first DF (109) via for the first
. "	DF.	Chair of fethical application, year of the crop relation and Island day	No Caise	1091	1091	(1991	GN	There are two femiliars applications of unions warre. The first DF / 1091 y is for the first application and the record DF (1140) is for the record application and the record DF (1140) is for the record application. Now that cach arbanized impre parameter value will have two impacts, use for each femilizer.
				-				\$2.55 (M.O.)
18	MFERT	Code for method of fortilization	No Unite		<u> </u>	i_	ON.	Code = 1 indicates that we organic (unimed wants or sewings studge) in applied. Code = 1 deductes incorporated destrictor or unique.
1.6	METHAT	Code for method of application.	No Uniu				ON .	Code = 1 depotes incorporated fartilizer or assistal waste. Code = 1 depotes psyloco ambication of fertilizer or maintail waste.
14	HTTPN	Code for misson where type	No Usiu	. 1	2		ON	Circle - I indicence that delay ceble mitted sease in solid form is applied.
1 1/2	IN INB	Farchine purpe. Lethine nemonia.	is to				NA.	Cord 17 is skipped if spino) meto u septical Cord 17 is skipped if soinal meto is applied.
U	EFEN FATRAT	Fernituse phosphores. Depth of acompanion.	16/9				, NA	Card I for alcipped (I salous) every is applied. Card I for skipped of salough evers is applied. Card I for skipped of salough evers is applied.
17	FXTTAT	Depth of water applied the foreignion.	- (15) - (45)				NA NA	Card 17 o supposi if someti, water is popular. Card 17 o skipped if soleni water is upplied.
ir	FATE	Application attribut more.	Us-Nam	5 00 1/91	3.00 3.00	5 (9) 3 (9)	ON	
18	DEFEN	Depth of incorporation	cm.		le e	jer .	ON	
16	AIN	Yotal stringer in animal waste	5	149				
			,	4.40	1.40	4.10	ON	
18	LPORGN	Organic wireigen cament je nečinal waste.	100	137	4,40 1,40	0 1.86 1.72	ON ON	
		Organic wireogen content in microsi waste.		4,40 137 3,12 106	2.72	7.72	0N	
"	458	Organic Witrogeo contract to animal wante. Anterodia contract in natural wrate.	1,	4,40 137 3,72 106 1.06	1.06	1.10 1.10 1.12 3.32 1.06 1.06 0.52	ON ON	
14	ANR JPHOS	Organic wireigen contents in naimal, state. Antentonia content in naimal state. Fotal priorphases content in naimal wants	10 10	1.57 1.57 1.06 1.06 1.06	3 73 1 06 1.06 0 82 9 82	1.06 1.06 9.52 0.87	6N 6N 6N	
/A	ANR APTIOS APOROF	Organic witingen cannon in naimal mate. Antoniolis content in salmal mater. First phosphare rooters in naimal mater. Chiganic phosphorus content in naimal mater.	% %	1.57 1.57 1.06 1.06 1.06	3 F2 1 06 1 06 0 82 0 82	3.32 1.06 1.06 0.52 0.87	0N 6N 6N 6N	
# # # # # # # # # # # # # # # # # # #	ANS APTIOS APOROF AOM	Оправо метора саложе је велом мене. Алежнік светов је карам мене. Гого разправочи метор је велом мене. Оправо разправочи метор је велом мене. Оправо разправочи соложе је велом мене. Оправо разправочи соложе је велом мене.	10 10 10 10 10 10 10 10 10 10 10 10 10 1	4,40 137 3,72 106 1.06	3 73 1 06 1.06 0 82 9 82	1.06 1.06 9.52 0.87	0K 0N 0K 0K	
/A	ANR APTIOS APOROF	Organic witingen cannon in naimal mate. Antoniolis content in salmal mater. First phosphare rooters in naimal mater. Chiganic phosphorus content in naimal mater.	% %	4,40 107 1,72 106 106 042 047 079 079	1.06 1.06 0.82 9.82 0.79 0.79	3.32 1.06 1.06 0.52 0.87 0.87 0.97 0.97 0.97	0N 6N 6N 6N	Code = 1 demons dus mans a in talle form.
18 18 19 19	ANS APPOSE APPOS	Olymic retrigon content to assistal resets Assessed content in assistal retrie first phosphorum content in assistal retrie Grapato phosphorum content in assistal retrie Grapato phosphorum content in assistal retrie Olymic states content in assistal retrie Frys of retrieval retrieval (a.g., assistal states, or liquid)	Si S	0.40 1.37 1.72 1.06 0.62 0.87 0.79 0.79 0.79 0.79	176 106 0 \$2 0 \$2 0 \$2 0 79 15 0	1.06 1.06 0.52 0.87 0.70 0.79 16.0 16.0	ON O	
# # # # # # # # # # # # # # # # # # #	ANS APTIOS APOROF AOM	Оправо метора саложе је велом мене. Алежнік светов је карам мене. Гого разправочи метор је велом мене. Оправо разправочи метор је велом мене. Оправо разправочи соложе је велом мене. Оправо разправочи соложе је велом мене.	10 10 10 10 10 10 10 10 10 10 10 10 10 1	0.40 1.37 1.72 1.06 0.62 0.87 0.79 0.79 0.79 0.79	176 106 0 \$2 0 \$2 0 \$2 0 79 15 0	3.32 1.06 0.52 0.87 0.87 0.70 9.79 86.0 86.0	0K 0N 0K 0K	
18 18 19 19	ANS APPOSE APPOS	Olymic retrigon content to assistal resets Assessed content in assistal retrie first phosphorum content in assistal retrie Grapato phosphorum content in assistal retrie Grapato phosphorum content in assistal retrie Olymic states content in assistal retrie Frys of retrieval retrieval (a.g., assistal states, or liquid)	Si S	4.40 1.07 3.52 1.08 1.08 0.02 0.07 0.79 44.0 86.0 1.1	176 1.06 0.82 0.82 0.79 0.79 18.0 16.0 1	3.32 1.06 0.52 0.87 0.79 0.79 86.0 1.1 1091 1091	ON O	Code - I dealers for transport in total from. When content any profess for foreign regions (Ling Annales Code). When content any profess for foreign regions (Ling Annales Code) (Ling Annales Code) (Ling Annales Code). When the code of the code
18 18 19 19	ANS APPOSE APPOS	Olymic retrigon content to assistal resets Assessed content in assistal retrie first phosphorum content in assistal retrie Grapato phosphorum content in assistal retrie Grapato phosphorum content in assistal retrie Olymic states content in assistal retrie Frys of retrieval retrieval (a.g., assistal states, or liquid)	Si S	4.80 1.07 1.06 1.06 0.02 0.07 0.79 0.79 0.79 0.79 0.79 1.10 1.10 1.10 1.10 1.10 1.10 1.10 1.1	3 75 1 06 1 06 0 82 0 82 0 79 2 79 2 80 1 109 1 109 1 109 1 1275	3.32 1.06 1.06 0.32 0.87 0.79 82.0 46.0 1 1.091 1.091 1.091 1.091	ON O	Thros within are specified for three separate ellipsy operation. The flavo NTDAY 11091 to the the Art witings operation, the recond NTDAY 11091 to the the Art witings operation, the recond NTDAY 11091 to the characteristic witings operation, and the which WithAY 11252 is for the distribution operation. Note that the decomposition of the which with the property operation which with the characteristic operation with the property of the condition of the conditions and the conditions are the conditions.
th t	ANN APRIOS APOROF AOM WASTEP NED-IS LEIS	Open verges commit is eated own. Attendes commit is beind were. Attendes commit is the service of the commit in the committee of the comm	16 15 16 16 16 No Unita No Unita	4.50 1.07 1.06 1.06 0.82 0.87 0.79 0.79 0.79 0.79 0.79 0.79 0.79 0.7	3 75 1 06 1 06 0 82 0 82 0 79 2 79 2 80 1 109 1 109 1 109 1 1275	3.32 1.06 1.06 0.52 0.87 0.79 0.79 0.60 0.60 0.60 0.60 0.60 0.60 0.60 0.6	08 08 08 08 08 08 08 08 08 08 08 08 08 0	Thros within are specified for three separate ellipsy operation. The flavo NTDAY 11091 to the the Art witings operation, the recond NTDAY 11091 to the the Art witings operation, the recond NTDAY 11091 to the characteristic witings operation, and the which WithAY 11252 is for the distribution operation. Note that the decomposition of the which with the property operation which with the characteristic operation with the property of the condition of the conditions and the conditions are the conditions.
a a y n	ANR APTIOS APOROF AOM WASTIP NIDAS LITE DID.	Oppose veriging common in soldinal water. Antiminan common in soldinal water. Antiminan common in soldina water. Oppose individual common soldina soldina. Oppose individual common soldinal water. Oppose soldinal common soldinal water. Free of soldinal common soldinal water. Free of soldinal common soldinal water. Free of soldinal common soldinal common soldinal disper- Code for soldinal common soldinal common soldinal disper- Engril of compression or of opposite user. Engril of compre	% % % % % % % % % % % % % % % % % % %	4.80 1.07 1.06 1.06 0.02 0.07 0.79 0.79 0.79 0.79 0.79 1.10 1.10 1.10 1.10 1.10 1.10 1.10 1.1	3 75 1 106 1 106 0 82 0 82 0 79 0 79 0 79 85 0 1 1 1 1091 1 1091 1 125	3.32 1.06 9.52 9.52 9.79 9.79 86.0 46.0 1.091 1091 1091 1091 1151	08 08 08 08 08 08 08 08 08 08 08 08 08 0	Thros within are specified for three separate ellipsy operation. The flavo NTDAY 11091 to the the Art witings operation, the recond NTDAY 11091 to the the Art witings operation, the recond NTDAY 11091 to the characteristic witings operation, and the which WithAY 11252 is for the distribution operation. Note that the decomposition of the which with the property operation which with the characteristic operation with the property of the condition of the conditions and the conditions are the conditions.
th t	ANR APTIOS APOROF BOM WASTYP NIDAS LITE DIR. KEEPING	Oppose verigine commod in solated water. Attention for commod in tablest water. Attention for commod in tablest water. Frief is equipment or commod in antice transit. Oppose commod commod in commod interest water. Frief of sound interest in a position forces water. Frief of sound interest in a position force included. Does of following, your of more production or completely commod following. Code to excigent the officer completeless or experience under Frief or 6 tology.	No Units	4.50 1 172 1 06 1 06 1 06 2 0 47 0 79 4 4 0 2 0 0 1 1 1 1091 1 10	2 /5 1 /06 0 /62 0 /62 0 /79 2 /79 2 /79 2 /79 1 /	3.32 1.06 0.52 0.87 0.87 0.87 0.87 0.87 0.87 0.80 1.09 1.09 1.09 1.09 1.09 1.09 1.09 1.0	08 08 08 08 08 08 08 08 08 08 08 08 08 0	These states are specified for their expects (Lingui specimen in the flow VILAX) (1991) in the last fiving operation, for most INAX) (1991) in the last fiving operation, and the specimen in the last INAX (1994) in the last Configure operation. What the last INAX (1994) is the last Configure operation. What the last INAX (1994) is the last INAX (1994) and for each obligate in the last INAX (1994) and for each obligate in the last INAX (1994) and for each obligate in the last INAX (1994) and INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (199
(1) (2) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	APR APRIOS APOROF AOM WASTIP NIDAS LITE DID. REFINS	Open weight commit is select ones. Attended commit is belief series. Attended commit is belief series. Organic blueghts on careful series. Organic blueghts of careful series and have day. Ones of tillage, part of corp retails on the self-blueght series. Organic blueghts of careful series. Organic blueghts of careful series. Organic blueghts of careful series.	No Units	4.40 1.37 1.08 1.08 1.08 2.00 2.00 1.1 1.09 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.09	2 15 1 106 1 106 0 22 0 79 2 79 2 80 1 108 1 108	3.32 1.06 0.51 0.51 0.57 0.79 0.79 0.79 1.09 1.09 1.09 1.09 1.09 1.09 1.09 1.0	08 08 08 08 08 08 08 08 08 08 08 08 08 0	Thros within are specified for three separate Ellings operations. The first NTDAY 11091 is the the Are things operation, the second NTDAY 11091 is the the Are things operation, the second NTDAY 11091 is the the account things operation, and the final shall will have been desired things operation, and the media of the second not the second things operation there are the media of the second things operation there are the media of the second things
th t	ANR APTIOS APOROF BOM WASTYP NIDAS LITE DIR. KEEPING	Organic religion commit in securi organic Antonicas control in securi organic Antonicas control in securi organic Priori phosphorum control in securi organic Organic relation control in securi organic Priori of securi organic control in securi organic Priori of securi organic in agree organic control Priori of securi organic in agree of securi organic Priori of securi organic in agree of securi organic Code in designate del (These Dephasmon or conjunction and Priori of States Information of security organic organic in agree Information of security organic organic Information of security organic organic Information of security organic Information of security organic Information organic organic Information of security organic Information organic	No Units	4.50 1 172 1 06 1 06 1 06 2 0 47 0 79 4 4 0 2 0 0 1 1 1 1091 1 10	2 /5 1 /06 0 /62 0 /62 0 /79 2 /79 2 /79 2 /79 1 /	3.32 1.06 0.52 0.87 0.87 0.87 0.87 0.87 0.87 0.80 1.09 1.09 1.09 1.09 1.09 1.09 1.09 1.0	ON O	These services or quotient for their expects of tager services. In Figs. NTLOX (1991) in the last of tager operation, the result NTLOX (1991) is the last of tager operation, the result NTLOX (1991) in the last of tager operation, and the 400 NTLOX (1992) in the last of tager operation. Nutrition of the services of tager operations when the last is tager, and for each obligate to the last of tager, and for each obligate on the last operation of the each obligate to the last operation of the each obligate of the each obligate operation of the each obl
(1) (2) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	APR APRIOS APOROF AOM WASTIP NIDAS LITE DID. REFINS	Opens weigen commit in earlied owner. Administrations in tentral states were. Analytic production in control and in the Congress of the Cong	No Units	4.40 1.37 1.08 1.08 1.08 2.00 2.00 1.1 1.09 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.09	2 15 1 106 1 106 0 22 0 79 2 79 2 80 1 108 1 108	3.32 1.06 0.52 0.52 0.57 0.79 0.79 0.79 1.09	08 08 08 08 08 08 08 08 08 08 08 08 08 0	These services or quotient for their expects of tager services. In Figs. NTLOX (1991) in the last of tager operation, the result NTLOX (1991) is the last of tager operation, the result NTLOX (1991) in the last of tager operation, and the 400 NTLOX (1992) in the last of tager operation. Nutrition of the services of tager operations when the last is tager, and for each obligate to the last of tager, and for each obligate on the last operation of the each obligate to the last operation of the each obligate of the each obligate operation of the each obl
### ##################################	ANR APTIOS APOROF AOM WASTIP NIDAS LITE DIPL KEEDIG FACE FACE FACE FACE FACE FACE FACE FACE	Organic religion commit in securi organic Antonicas control in securi organic Antonicas control in securi organic Priori phosphorum control in securi organic Organic relation control in securi organic Priori of securi organic control in securi organic Priori of securi organic in agree organic control Priori of securi organic in agree of securi organic Priori of securi organic in agree of securi organic Code in designate del (These Dephasmon or conjunction and Priori of States Information of security organic organic in agree Information of security organic organic Information of security organic organic Information of security organic Information of security organic Information organic organic Information of security organic Information organic	No Units	4.40 1.37 1.08 1.08 1.08 2.00 2.00 1.1 1.09 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.1 1.09 1.09	2 75 1 106 1 106 1 082 0 22 0 79 2 50 1 10 1 10 1 10 1 10 1 10 1 10 1 10 1	3.12 1.06 1.06 0.37 0.37 0.37 0.37 0.37 0.37 1.09	086 688 008 008 008 008 008 008 008 008	These states are specified for their expects (Lingui specimen in the flow VILAX) (1991) in the last fiving operation, for most INAX) (1991) in the last fiving operation, and the specimen in the last INAX (1994) in the last Configure operation. What the last INAX (1994) is the last Configure operation. What the last INAX (1994) is the last INAX (1994) and for each obligate in the last INAX (1994) and for each obligate in the last INAX (1994) and for each obligate in the last INAX (1994) and INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (199
α α α α α α α α α α α α α α α α α α α	APRIOS APOROP APOROP AOM WASTIP NIDAS LEB DED. SEETING FMAX PD STE MP ATEL	Organic religion control in section device. Antonional relation in section service. Antonional relation in section service. Organic phosphore or marker in section service. Organic phosphore or marker in section service. Organic phosphore or marker in section service. Partie of section service is good section value. Date of following near of comprehensive and historia day. Cade to designing near of comprehensive or comprehensive service. Frigund of Comprehensive or comprehensive service. Date of Section Service service service service service. Section Service service service service service. Number of Comprehensive service services.	No Units	4.40 1.07 1.08	2 15 1 106 1 106 1 0 42 0 42 0 79 1 50 0 1 11091 1 1091 1	3.12 1.06 0.52 0.87 0.87 0.87 0.87 0.87 0.87 0.87 0.87	ON O	These states are specified for their expects (Lingui specimen in the flow VILAX) (1991) in the last fiving operation, for most INAX) (1991) in the last fiving operation, and the specimen in the last INAX (1994) in the last Configure operation. What the last INAX (1994) is the last Configure operation. What the last INAX (1994) is the last INAX (1994) and for each obligate in the last INAX (1994) and for each obligate in the last INAX (1994) and for each obligate in the last INAX (1994) and INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (1994) are also in the last INAX (1994) and INAX (1994) are also in the last INAX (199
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	AVAR OPTION APPROP	Organis religios commos in salario desire. Antiminario resirente la sessió servici. Antiminario resirente la cilia de la commo della com	No Original No Ori	4 401 1.27 1.27 1.27 1.27 1.27 1.27 1.27 1.2	2.15	3.22 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1	(N)	These man are specified to their explose (stage specimen for some liver) in the first WHAY (1991) to the first specimen for some strict WHAY (1991) to the first specimen for some strict which was not been strictly as the strict which was not been strictly as the strictly as the strictly specimen for which will be not their specimen for such a single parameter when will be not true specimen and a such disks and the strictly specimen for such a single parameter when will be not true specimen as a single specimen for such as the strictly specimen
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## 10 mm ## 10 mm	AVR APTICS APOSTON APO	Organis mitigan common in section device. Antiminary common in section device. Antiminary common in section section. Departs phosphore or material as section from the Common in section of the Common in section in section of the Common in section of the Common in section in section in section of the Common in section in	No Original No Ori	4 401 1.77 1.77 1.77 1.77 1.78 1.78 1.78 1.7	3.15	3.22 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1	(26) (26) (26) (26) (26) (26) (26) (26)	These means are specified to their explane (stage specified in the first WHAY (1991) to the last of management of the specified in the specifi
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## ## ## ## ## ## ## ## ## ## ## ## ##	458 458 459 459 459 459 459 459 459 459 459 459	Organic religion common in material research Antimican formation in material research Front in completion common and material research Organic relation common an employment of the completion of the completio	No. Other No. Ot	4 301 1.77 1.77 1.77 1.77 1.77 1.78 1.78 1.7	3.15	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	(28) (28) (28) (29) (29) (29) (29) (29) (29) (29) (29	These return an expended for their expected large spectrum for the first HEAVE (1991) for the first HE
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## 10 P P P P P P P P P P P P P P P P P P	######################################	Organic religion common in season desire. Antonies in control in season service. Antonies in control in season service. Organic phraphics or marker in season season. Parties of season season in season season. Parties of season season in season season. Parties of season season season season season. Parties of season season season season or represent season. Parties of season season season or represent season. Parties season season season season or represent season season. Parties season season season season season. Parties season season season season season season. Season season season season season season season. Season season season season season season season. Season season season season season season. Season season season season season season season.	No. Other No. Ot	4 301 1.77 1.77 1.77 1.77 1.77 1.78 1.78 1.7	3.15	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	(26) (26) (26) (26) (26) (26) (26) (26)	These many we provide the time support stages around the first NTAN (1991) and the Art of 1991 are the Art of 1992 are the Art
## 10 P P P P P P P P P P P P P P P P P P	AND STATE OF	Organis religios commos in securio servici. Antoninos reservos in securio servici. Antoninos reservos in calestina servici. De para phraginar a marcin in securio servici. De para phraginar a marcin in securio securio. Organis phraginar a marcin in securio securio. Organis canton commos securios securios securios. Para of securios securios securios securios securios del Prima del Control del Control del Prima del Control del Prima del Control del Prima del Control del Con	No. Control Co	4 401 1 17 1 17 1 17 1 17 1 17 1 17 1 17 1	3.15	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	(28) (28) (28) (28) (28) (28) (28) (28)	These many we provide the time support stages around the first NTAN (1991) and the Art of 1991 are the Art of 1992 are the Art
10 10 10 10 10 10 10 10 10 10 10 10 10 1	######################################	Organic religion common in season desire. Antonies in control in season service. Antonies in control in season service. Organic phraphics or marker in season season. Parties of season season in season season. Parties of season season in season season. Parties of season season season season season. Parties of season season season season or represent season. Parties of season season season or represent season. Parties season season season season or represent season season. Parties season season season season season. Parties season season season season season season. Season season season season season season season. Season season season season season season season. Season season season season season season. Season season season season season season season.	No. Control Co	4 447 177 177 177 177 177 177 177 177 17	1.00	3.21	(26) (26) (26) (26) (26) (26) (26) (26)	These many we provide the first respect to the group of the PATHON (1991) to the dar of the group operation the count NACA (1991) is the dar of the 1991 to the second to the text before the text by the respect agent, and for each being many to the 1991 to the 1
## 10 P P P P P P P P P P P P P P P P P P	AND STATE OF	Organis religios commos in securio servici. Antoninos reservos in securio servici. Antoninos reservos in calestina servici. De para phraginar a marcin in securio servici. De para phraginar a marcin in securio securio. Organis phraginar a marcin in securio securio. Organis canton commos securios securios securios. Para of securios securios securios securios securios del Prima del Control del Control del Prima del Control del Prima del Control del Prima del Control del Con	No. Control Co	4 data 4 d	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.32 0.32 0.32 0.32 0.32 0.32 0.32 0.32 0	(28) (28) (28) (28) (28) (28) (28) (28)	These many we provide the time support stages around the first NTAN (1991) and the Art of 1991 are the Art of 1992 are the Art
## 10 P P P P P P P P P P P P P P P P P P	APRIL	Organic religion common in material service. Antimican formation in material service. Front of common common and common common common common and common co	No. Other Street, No. Other St	4 441 177 177 177 177 177 177 177 177 177	1 100 0 10 100 0 10 100 0 10 10 10 10 10	1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	(26) (26) (26) (26) (26) (26) (26) (26)	These are two findings against an area against all against an area for the first against a control of the first against agains
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## 10 P P P P P P P P P P P P P P P P P P	APRIL	Organic religion common in material service. Antimican formation in material service. Front of common common and common common common common and common co	No. Other Street, No. Other St	4 data 4 d	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	(26) (26) (26) (26) (26) (26) (26) (26)	These are two findings against an area against all against an area for the first against a control of the first against agains
## 10 mm	DIRECTOR OF THE PROPERTY OF TH	Organic reliago commo in securió servici. Antomica vicaren la securió servici. Antomica vicaren la securió servici. Organic phesphora e cuentre la securió servici. Prese del compositio como sed haban describidad, pera el recipio periode del compositio como sed haban describidad, pera el recipio periode del compositio como sed haban describidad, pera el recipio periode del compositio del c	No. Other No. Ot	4 10 10 10 10 10 10 10	1.00 0.42 0.42 0.42 0.42 0.42 0.42 0.42 0	1.32 0.22 0.22 0.27	(28) (28) (28) (28) (28) (28) (28) (28)	These are two findings against an area against all against an area for the first against a control of the first against agains
## ## ## ## ## ## ## ## ## ## ## ## ##	PATTI	Organic religion common in securio service. Antomica vicarea in securio service. Antomica vicarea in securio service. Organic phesiphora o marcor in activa service. Forganic and in activa service service and hashe done Forganic and in activa service and hashe done Forganic and independent or experience used. Forganic and Congress and Antomica and inches and in	No. Other No. Ot	4 10 10 10 10 10 10 10	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	(28) (28) (28) (28) (28) (28) (28) (28)	These are two findings against an area against all against an area for the first against a control of the first against agains

The projection appeals parameter a teal appeal of user abusiness larger periods unique professioness, and parameter colors for particular method applications in a product of colors and projection and applications of a product of colors application.

Colors are parameter than the project of colors and application and colors and colors are applications and applications and applications are applications are applications and applications are applications and applications are applications are applications and applications are applications are applications and applications are applications are applications are applications and applications are applic

Dr. Engel's Plant Nutrient Parameter Input File for Forest Land Use Table B-7.

Sources of information:

1) GLEAMS parameter input values were euroscied from the 1N° PAR files located in the ILLINOIS, BARRONFORT, and CANEYCREEK sub-folders in the following directory: "N URWIAWIESport Reports/Engel-Materials/Gleams_Finals11_FUTURE_1009R1*"

2) Krisel, W.G. and Davis, F. M. 2001. GLEARS (Groundwater Loading Effects of Agricultural Management Systems), Version 3.0. User Manual. Pub. No. SEWRL-WGK, FMD-050199.
3) "Expert Report" refers to "Paultry Waste Generation and Land Application in the Illinois River Watershed and Phosphorus Lauks to the Illinois River Watershed Streams and Rivers and

Lake Tenkiller, Expert Report of Dr. B. Engel, Far State of Oklahoma, In Case Na. 01-CU-329-GKF-SAJ, State of Oklahoma v. Tyson Foods, et al. (In the United States District Court for the Northern District of Oklahoma), Dr. B. Engel, P.E. Professor of Agricultural and Biological Engineering, May 22,2708*

4) E-mail correspondence on Wednesday, August 13, 2008 8-27 AM, From David Page, To Robert Grorge, Louis Bullock, David Riggs, Elizabeth Claire Xidis, Subject, RE: Folkov Up Hens from July 11 Teleconference with Dr. Engel

Plant Nutrient Parameter Input File for Forest Land Use (INF.PAR)

	Parameter	Parameter			Parumeter Value		Source of	
Card #	Name	Description	Unit	Illinois	Baron	Cancy	Parameter Value	Comment
		Three 80-character lines of alphanumeric information that		River	Fork	Creek		
		identifies the particular computer run. For example, the soil						The run description does not provide any information regarding the site-specific
1-3	TITLE	type, the erop rotation, the tillage practices, may be useful in identifying	No Units				GN	application to the IRW. The run description is a generic description that was taken from an example input file on p. 189 of the GLEAMS user manual.
		the file and specific GLEAMS application.]		an example input the on p. 189 of the CC,EAM'S user framual.
4	NBYR	Beginning year of plant nutrient simulation.	Year	1901	1901	1901	AS	
4	NEYR NUTOUT	Ending year of plant nutrient simulation. Code to designate level of printed notricut output.	Year No Units	2000	2000	2000 2	AS AS	
7	FLGROT	Number of years in a crop rotation cycle.	No Units	1	1	1	AS	
1	FLGBAL	Code for output of N and P balance at the end each year of	No Units	0	0	ft	AS	
		si mulation.		-				
5	RESDW	Crop residue on the ground surface when simulation begins.	kg/ha				DF	
3	RCN	Nitrogen concentration in rainfall.	ppns				DF	
5	CNI CPI	Engeentration of nitrate-nitrogen in irrigation. Concentration of labile-phosphorus in irrigation.	ppm ppm		ļ	ļ	DF D#	
6	TNO	Total nitrogen in each soil hortzon	%				DIF	
	INU	(Number of soil horizons # 5)	70				DI	
7	CNIT ₀	Nitrate-nitrogen concentration in each soil horizon. (Number of soil horizons = 5)	ug/g				Ø₹.	
8	POTMN()	Potentially mineralizable nitrogen in each scal horizon. (Number of soil horizons = 5)	kg/ha				DF	
9	ORGNW	Organic nitrogen cunlent from animal waste in the plow horizon.	%				DF	
10	TPO	Total phosphorus in each soil horizon. (Number of suil horizons= 5)	%				DF	
11	CLAB()	Labile phosphorus concentration in each soil horizon. (Number of soil horizons × 5t	ug/g	20	20	25	CAL	CLAB input values are the same for all soil horizons. Labile phosphorus input values were manually modified during lite ealibration process.
12	ORGPW	Organic P content from animal waste in plow horizon.	%				DF	
13	PDATE	Date that the following parameters are valid, year of the crop rotation cycle and Julian day.	No Units	1001	1001	1991	GN	
14	NF	Number of Jertilizer and animal waste applications during the update period.	Nn Units				DF	
14	NTIL	Number of tillage operations during the update period.	No Units				DF	
14	DIIRFST	Date of crop harvest, year of the crop rotation cycle and Julian day.	No Units				DF	
15	ICROP	Identification number of the crop grown during this cropping period.	No Units	69	69	69	GN	Trees-conifer is the crop type specified.
15	LEG	Code fitt legame crop.	No Units				DF	
15	PY	Potential yield for the harvestable portion of the crop.	kg/ha				DF	
15	DMY	Dry matter ratio, the ratio of total dry matter production to harvestable portion of the crop.	Nu Units			1	DF	
15	CAR	Carbon:nitrogen ratio for the crop.	No Units			ļ	DF	
15	RNP	Ratio of erop nitrogen to phosphorus Coefficient in the exponential relation to estimate nitrogen	No Units			 	DF	
15	CI	content of the crop.	No Units		l		DF	<u>.</u>
15	C2	Exponent in the exponential relation to estimate nitrogen content of the crop.	No Units				DF	
		Date of fertilizer application, year of the crop rotation and			 	 		
16	DF	Julian day.	Na L'nits		L	L	NA.	
16 16	MFERT METILAP	Code for method of fertilization. Code for method of application.	No Units No Units		 	 	NA NA	
16	METHAP	Code for animal waste lype.	No Units		 	 	NA NA	
17	FN	Fertilizer nitrate	kg/ha	l	1	 	NA NA	
17	FNII	Fertilizer anunonia.	kg/ha			1	NA NA	
17	FP	Fertilizer phosphorus.	kg/ha				NA	
17	DEPIN	Depth of incorporation.	cm		ļ		NA.	
17	FRTWAT	Depth of water applied for fertigation.	em		 		NA.	
18	RATE	Application rate for animal waste. Depth of incurporation.	tn/hs		 	-	NA NA	
18	ATN	Total nitrogen in animal waste.	em %	 	 	 	NA NA	
18	APORGN	Organic rutrogen conlent in animal waste.	%	İ	1	t	NA.	
18	ANH	Ammonia content in unimal waste.	%		L	1	NA	
18	APHOS	Total phosphorus cunient in animal waste.	%	l			ÑΑ	
18	APORGP	Organie phosphorus content in animal waste.	%		T		NA NA	
18	AOM	Organic matter content in animal waste.	%	ļ			NA.	
18	WASTYP	Type iif animal waste (e.g., solid, slurry, or liquid)	No Units		 	 	NA	
19	NTDAY	Date of tillage, year of erop rotation cycle and Julian day.	No Units	ļ			NA	
		Code to designate the fillage implement or equipment used.	No Units	l	I	l	NA	
19	LTIL				 	 	52.4	
19 19	DTIL EFFINC	Depth of tillage. Efficiency of incorporation of surface residue.	om No Units				NA NA	

Application specific parameter value applied to set simulation time periods, output preferences, and parameter codes for particular method applications (e.g., method of fertilization).

GLEAMS default parameter value applied

Calibrated parameter value applied

Ceneric or example value from p.191 of the GLEAMS user manual applied unless noted otherwise.

Not applicable. Parameter input value man you to be required if certain model attributes are not selected. For example, parameter inputs required for fertilizer application would not be required if a particular land use or field is not fertilized.

Site-specific parameter value applied.

Dr. Engel's Plant Nutrient Parameter Input File for Urban Land Use Table B-8.

Sources of information:

- 1) GLEAMS parometer input values were extracted from the 1N* J'AR files located in the ILLINOIS, BARRONFORT, and CANEYCREEK sob-folders
- in the following directory: "N-URPLAWIE-spert, Reports/Engel/Moterials-Gleant, Finolst. LEUTURE, 1007Rc**
 2) Knicel, W.G. and Davit, F.M. 2000. GLEAMS (Groundwater Looding Effects of Agricultural Management Systems), Versión 3.0. User Montal. Pub. No. SEWRU-WGK/FMD-050199
- 3) "Expert Report" refers to "Poultry Waste Generation and Land Application in the Illinois River Waterthad and Phosphoras Loads to the Illinois River Waterthad Streams and Rivers and Lake Tenkiller, Expert Report of Dr. B. Engel, For State of Oklahomo, In Case Na. 05-CU-329-GKF-SA1, State of Oklahoma v. Tyron Foods, et al. (In the United States District Court for the
- Anthorn Duries of Oklahom). P. E. Brigel, P. E. Paylessor of Agrizulturol and Biological Engineering, May 22,2008.

 4) E-mail curveypoulance on Reducaday, August 13, 2008. 3:71 Al. From David Page, To Robert George, Lovid Bullock, Dovid Riggs, Elizabeth Claire Xida;
 Subject, RE. Follow Up I lend from July 11 Teleconformed with Dr. Engel.

Plant Nutrient Parameter Input File for Urban Land Use (INU.PAR)

7 14711 7 14	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	ameter input rite for Orban Lana Ose (1)			•	219000130001		
		A			Parameter Value		Source of	
Card#	Parameter Name	Parameter Description	Unit	Illinois	Baron		Parameter	Comment
	1,000	DESCRIPTION		River	Baron Fork	Cancy Creek	Value	
		Three 80-character lines of alphanumerie information that		Airer	7078	Vees.		
		identifies the particular computer run. For example, the soil						The run description does not provide any information regarding the site-specific
1-3	TITLE	type, the crop ratation, the tillage practices, may be useful	No Units				GN	application to the IRW. The run description is a generic description that was taken from
		in identifying						an example input file on p. 189 of the GLEAMS user manual.
		the file and specific GLEAMS application.						
4	NBYR	Beginning year of plant nutrient simulation.	Year	1901	1901	1901	AS	
4	NEI'R	Ending year of plant nutrient simulation.	Year	2000	2000	2000	AS	
1	NUTOUT	Code to designate level to printed nutrient output.	No Units	2	2	2	AS	
4	FLGROT	Number of years in a erop rotation cycle.	No Units	1	_	į	AS	
4	FLGBAL	Code for output of N and P bulance at the end each year af	No Units	0	0	-0	AS	
	FLUBAL	simulation.	No cours	· ·			Λ.,	
5	RESDW	Crop residue on the ground surface when simulation begins.	kg/ha				DΕ	
5	RCN	Nitrogen concentration in rainfall.	pp/n				DF	
5	CNI	Concentration of nitrate-nitrogen in irrigation.	ppm				DF	
5	CPI	Cancentration of labile-phosphorus in irrigation.	ppm				DF	
6	TNO	Total nitrogen in each soil horizon.	%				DF	
		(Number of soil horizons = 5)						
7	CNIT()	Nitrate-nitrogen concentration in each soil horizon. [Number of soil horizons = 5]	ug/g				DF	į
ļ		[Number of soil horizons = 5]			ļ			
8	POTMN()	Patentially mineralizable nitrogen in each soil horizon.	kg/ha		l		DF	
	JOIMN()	(Number of soil horizons = 5)	Ng/11a		l	1	D.	
		Organic nitrogen content from animal waste in the plow			l	···		
9	ORGNW	horizon.	%		l		DF	
	-	Total phosphorus in each soil horizon.						
10	TPO	(Number of soil horizons= 5)	%			1	DF	
11	CLAB()	Labile phosphorus concentration in each soil horizon. (Number of soil horizons = 5)	ug/g		1]	DF	
l		(Number of soil horizons # 3)						
/2	ORGPW	Organic P content from animal waste in plow horizon.	%				DF	1
12	UKGPH	Organic r content from animat waste in piow norizon.	74				Dr	
		Date that the following parameters are valid, year af the		1003	1001	1001	(0)	
13	PDATE	crop rotation cycle and Julian day.	No Units	1001	1001	1001	GN	
ļ		Number of fertilizer and animal waste applications during	 	 				
14	NF	the update period.	No Units	0	0	0	GN	
								
14	NTIL	Number of tillage operations during the update period.	No 1/nits	0	0	0	GN	
		Date of crop harvest, year of the crop rotation eyele and						
14	DHRVST	Julian day.	No Units	10366	10366	10366	AS	
	 	l		ļ	 			
15	ICROP	Identification number of the crop grawn during this	No Units	2	2	2	AS	Alfalfa-hay is the crop type specified.
15	LEG	cropping period. Code for legume crop.	No Units			 	DF	
	1		†			 		
15	PY	Patential yield for the harvestable portion of the crop.	kg/ha			1	DE	
		Dry matter ratio, the ratio of total dry matter production to				 		
15	DMY	harvestable portion of the crop.	No Units				DF	
15	CNR	Carbon nitrogen ratio for the crop.	No Units				DF	
15	RNP	Ratio of crop nitrogen to phosphorus.	No Units				DF	
		Coefficient in the exponential relation to estimate nitrogen	1		· · · · · · · · · · · · · · · · · · ·	 		
15	CI	content of the erop.	No Units			İ	DF	
	C2	Exponent in the exponential relation to estimate nitrogen					DE	
15	C.2	content of the crop.	No Units	L	L		Lit.	
16	DF	Date of fertilizer application, year of the crop rotation and	No Units			I	NA.	
L		Julian day		L		L		
16	MFERT	Code for method of fertilization.	No Units				NA	
16	METHAP	Code for method of application.	No Units				NA	
16	MTYPE	Code for snimal waste type.	No Units				NA.	
17	FN	Fertilizer nitrate	kg/ha				NA.	
17	FNR	Fertilizer ammonia	kg/ha				NA.	
	FP	Fertilizer phosphorus	kg/ha		L		NA.	
17	DEPEN	Depth of incorporation.	cm	L			NA	
17	FRTWAT	Depth of water applied for fertigation.	em			L	NA	
/8	RATE	Application rate for animal waste.	tn/ha				NA.	
18	DEPIN	Depth of incorporation.	cm				NA	
18	ATN	Total nitrogen in animal waste.	%			I	NA	
18	APORGN	Organic nitrogen content in animal waste.	%		L		NA	
18	ANH	Ammonia content in animal waste.	%				NA	
	, ngo:		%	I	1	1		
18	APHOS	Total phosphorus cantent in animal waste.	76	1			NA	
18	APORGP	Organic phosphorus content in animal waste.	%		1	†	NA	
18	AOM	Organic matter content in animal waste.	%	1	T	T	NA.	
18	WASTYP	Type of animal waste (c.g., solid, sturry, or liquid).	No Units	t	T	T	NA.	
		· ·		f	1	1		
19	NTDAY	Date of tillage, year of crop rotation cycle and Julian day.	No Units	I	I	ĺ	NA	
	 	<u> </u>	 	 	 	 	 	<u> </u>
19	LTIL	Code to designate the tillage implement or equipment used.	No Units	l	l	1	NA	1
19	DTIL	Depth of tillage.	cm	t	t	†	NA	
19	EFFINC	Efficiency of incorporation of surface residue.	No Units	t -	—	†	NA NA	<u> </u>
//	FMIX	Tillage mixing efficiency.	No Units		t	 	NA.	
<u> </u>			C.u.o	•				·

- Application specific parameter value applied to set simulation time periods, output preferences, and parameter codes for particular method applications (e.g., method of fertilization).

 GLEAMS default parameter value applied.

 Calibrated parameter value applied.

 Calibrated parameter value applied.

 Genetics or example value from p. 191 of the GLEAMS user manual applied unless noted atherwise.

 Not applicable. Parameter input value may not be required if certain model attributes are not selected. For example, parameter inputs required for fertilizer application would not be required if a particular land use or field is not fertilized.

 Site-specific parameter value applied. AS DF CAL GN NA

APPENDIX C

LOADEST RESULTS FOR PHOSPHORUS LOADS TO LAKE TENKILLER

Total P Loads for Illinois River near Tahlequah for 1997-2006 Estimated Using LOADEST Table C-1.

Illinois Ri	inois River at Tahlequah LOADI	LOADEST-Estimated Annual TP Loads in pounds	ads in pounds		
			1	Corrected LOADEST Results -	ults -
		Engel Produced			
	Engel Expert Report	Materials			
Year	Table 5.3	(i.e., p_model_10_15.xls)	Middle Year	First Year	Third Year
1997	211,467	not presented	168,072	232,534	no result
1998	422,906	406,124	504,682	292,349	318,794
1999	392,336	376,767	404,724	433,715	527,948
2000	771,454	740,840	857,099	858,316	973,574
2001	456,947	438,814	509,853	532,085	557,311
2002	301,474	289,511	341,368	387,119	340,387
2003	94,684	90,927	107,375	114,172	124,336
2004	631,798	606,727	652,712	626,108	563,502
2005	258,021	247,782	240,690	236,909	212,516
2006	128 415	123.319	104,636	no result	120,086

Total P Loads for Baron Fork at Eldon for 1997-2006 Estimated Using LOADEST Table C-2.

Baron Fo	rk at Eldon LOADEST-E	Baron Fork at Eldon LOADEST-Estimated Annual TP Loads in pounds	spunod u		
				Corrected LOADEST Results -	ults -
		Engel Produced			
	Engel Expert Report	Materials			
Year	Table 5.3	(i.e., p_model_10_15.xls)	Middle Year	First Year	Third Year
1997	25,500	not presented	25,560	51,360	no result
1998	39,887	38,304	103,020	75,536	49,836
1999	49,755	47,781	60,118	009'29	63,303
2000	298,307	286,470	409,358	438,860	584,858
2001	98,931	92,006	111,653	105,981	102,643
2002	52,666	50,576	60,839	92,570	66,107
2003	10,107	902'6	10,725	9,610	12,517
2004	459,054	440,838	432,887	414,406	344,516
2005	68,639	65,915	65,131	73,938	29,867
2006	58,300	55,986	55,376	no result	54,087

Total P Loads for Caney Creek near Barber for 1997-2006 Estimated Using LOADEST Table C-3.

Caney Cr	Caney Creek near Barber LOADE	LOADEST-Estimated Annual TP Loads in pounds	ads in pounds		
			Cor	Corrected LOADEST Results -	ults -
		Engel Produced			
	Engel Expert Report	Materials			
Year	Table 5.3	(i.e., p_model_10_15.xls)	Middle Year	First Year	Third Year
1997	4,140	not presented	incomplete data	incomplete data	incomplete data
1998	9,024	8,665	7,929	9,264	incomplete data
1999	8,349	8,017	9,091	13,854	10,062
2000	55,787	53,573	42,920	49,545	18,926
2001	36,616	35,163	34,461	37,382	35,770
2002	16,574	15,916	14,143	7,774	13,018
2003	3,485	3,347	2,997	2,595	3,893
2004	57,086	54,821	14,961	67,053	19,266
2005	14,004	13,448	15,165	16,116	6,541
2006	10,574	10,154	11,563	no result	11,772

Sum of Total P Loads for Illinois River, Baron Fork and Caney Creek for 1997-2006 Estimated Using LOADEST Table C-4.

Totaled II	RW LOADEST-Estimated	otaled IRW LOADEST-Estimated Annual TP Loads in pounds	S		
				Corrected LOADEST Results -	ults -
		Engel Produced			
	Engel Expert Report	Materials			
Year	Table 5.3	(i.e., p_model_10_15.xls)	Middle Year	First Year	Third Year
1997	241,107	not presented	incomplete data	incomplete data	incomplete data
1998	471,817	453,093	615,632	377,149	incomplete data
1999	450,440	432,566	473,932	515,168	601,313
2000	1,125,548	1,080,883	1,309,377	1,346,721	1,577,358
2001	592,494	568,983	655,967	675,448	695,723
2002	370,714	356,003	416,349	487,464	419,513
2003	108,276	103,980	121,096	126,377	140,746
2004	1,147,938	1,102,386	1,100,560	1,107,567	927,284
2005	340,664	327,145	320,986	326,963	278,924
2006	197.289	189.459	171,574	no result	185,945

Total P Loads for the Illinois River near Tahlequah for 2005-2007 Estimated Using LOADEST Table C-5.

Illinois River at Tahl	linois River at Tahlequah LOADEST-Estimated Ani	ated Annual TP Loads in pounds	spuno			
			1/6/2008 AMLE Loads	Dr. Wells Model	Dr. Wells Model	Corrected
		Engel Produced	Provided by Engel to Wells	Calibration Tributary	Calibration Tributary	TP Loads
	Engel Expert Report	Materials	to Develop Boundary	Run 200 Inputs	Run 400 Inputs	(LOADEST applied to
Year	Table 5.3	(i.e., p model 10 15.xls)	Conditions	(May 2008 Expert Report)	(8/26/2008 Errata)	2005-2007)
2005	258.021	247.782	273,155	270,427	270,389	236,909
2006	128,415	123,319	104,476	103,364	103,244	104,636
2007 (Jan-Sep)	not presented	not presented	149,953	150,076	149,558	146,166

Table C-6. Total P Loads for Baron Fork at Eldon for 2005-2007 Estimated Using LOADEST

Baron Fork at Eldon	aron Fork at Eldon LOADEST-Estimated Annual	nnual TP Loads in pounds				
			1/6/2008 AMLE Loads	Dr. Wells Model	Dr. Wells Model	"Corrected"
		Engel Produced	Provided by Engel to Wells	Calibration Tributary	Calibration Tributary	TP Loads
	Engel Expert Report	Materials	to Develop Boundary	Run 200 Inputs	Run 400 Inputs	(LOADEST applied to
Year	Table 5.3	(i.e., p model 10 15.xls)	Conditions	(May 2008 Expert Report)	(8/26/2008 Errata)	2005-2007)
2005	68.639	65,915	69,930	69,714	69,762	73,938
2006	58.300	55,986	62,844	59,430	59,355	55,376
2007 (Jan-Sep)	not presented	not presented	65,003	63,732	63,706	54,040

Table C-7. Total P Loads for Caney Creek near Barber for 2005-2007 Estimated Using LOADEST

Caney Creek near B	aney Creek near Barber at LOADEST-Estimated A	mated Annual TP Loads in pounds	spunod			
			1/6/2008 AMLE Loads	Dr. Wells Model	Dr. Wells Model	"Corrected"
		Engel Produced	Provided by Engel to Wells Calibration Tributary	Calibration Tributary	Calibration Tributary	TP Loads
	Engel Expert Report	Materials	to Develop Boundary	Run 200 Inputs	Run 400 Inputs	(LOADEST applied to
Year	Table 5.3	(i.e., p_model_10_15.xls)	Conditions	(May 2008 Expert Report)	(8/26/2008 Errata)	2005-2007)
2005	14,004	13,448	16,365	16,388	16,358	16,116
2006	10,574	10,154	11,995	12,396	12,353	11,563
2007 (Jan-Sep)	not presented	not presented	13,382	6,248	6,243	8,897

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Sum of Total P Loads for the Illinois River, Baron Fork and Caney Creek for 2005-2007 Estimated Using LOADEST Table C-8.

Totaled IRW LOADESI-Estimated Annual 1P Loads in pounds			1/6/2008 AMI F Loads	Dr. Wells Model	Dr. Wells Model	"Corrected"
		Engel Produced	Provided by Engel to Wells		Calibration Tributary	TP Loads
	Engel Expert Report	Materials	to Develop Boundary	Run 200 Inputs	Run 400 Inputs	(LOADEST applied to
Year	Table 5.3	(i.e., p model 10 15.xls)	Conditions	(May 2008 Expert Report)	(8/26/2008 Errata)	2005-2007)
2005	340.664		359,451	356,530	356,509	326,963
2006	197,289	189,459	179,315	175,189	174,951	171,574
2007 (Jan-Sep)	not presented	not presented	228,338	220,057	219,506	209,103

SRP Loads for the Illinois River near Tahlequah for 2005-2007 Estimated Using LOADEST Table C-9.

HILDIS LIVER AL IAIII	IIIIOIS RIVEL AL LAIIIEGUAII - SINT COAUS III DOULIUS	2000				
			1/6/2008 AMLE Loads	Dr. Wells Model	Dr. Wells Model	
		Engel Produced	Provided by Engel to Wells	Calibration Tributary	Calibration Tributary	"Corrected"
	Engel Expert Report	Materials	to Develop Boundary	Run 200 Inputs	Run 400 Inputs	SRP Loads (LOADEST
Year	Table 5.3	(i.e., p model 10 15.xls)	Conditions	(May 2008 Expert Report)	(8/26/2008 Errata)	applied to 2005-2007)
2005	not presented	not presented	132,506	129,620	129,620	107,900
2006	not presented	not presented	72,939	71,623	71,623	65,987
2007 (Jan-Sep)	not presented	not presented	104,890	104,410	104,410	94,253

Table C-10. SRP Loads for Baron Fork at Eldon for 2005-2007 Estimated Using LOADEST

Baron Fork at Eldon	aron Fork at Eldon - SRP Loads in pounds					
			1/6/2008 AMLE Loads	Dr. Wells Model	Dr. Wells Model	
		Engel Produced	Provided by Engel to Wells Calibration Tributary	Calibration Tributary	Calibration Tributary	"Corrected"
	Engel Expert Report	Materials	to Develop Boundary	Run 200 Inputs	Run 400 Inputs	SRP Loads (LOADEST
Year	Table 5.3	(i.e., p model 10 15.xls)	Conditions	(May 2008 Expert Report)	(8/26/2008 Errata)	applied to 2005-2007)
2005	not presented		18,773	18,780	18,780	11,834
2006	not presented	not presented	17,996	14,144	14,144	9,752
2007 (Jan-Sep)	not presented	not presented	20,039	18,079	18,079	11,520

Table C-11. SRP Loads for Caney Creek near Barber for 2005-2007 Estimated Using LOADEST

Caney Creek near B	Saney Creek near Barber - SRP Loads in pounds	spunds				
			1/6/2008 AMLE Loads	Dr. Wells Model	Dr. Wells Model	
		Engel Produced	Provided by Engel to Wells	Calibration Tributary	Calibration Tributary	"Corrected"
	Engel Expert Report	Materials	to Develop Boundary	Run 200 Inputs	Run 400 Inputs	SRP Loads (LOADEST
Year	Table 5.3	(i.e., p model 10 15.xls)	Conditions	(May 2008 Expert Report)	(8/26/2008 Errata)	applied to 2005-2007)
2005	not presented	not presented	998'9	6,870	6,870	3,165
2006	not presented	not presented	4,264	4,249	4,249	2,067
2007 (Jan-Sep)	not presented	not presented	5,798	3,364	3,364	2,894

Table C-12. Sum of SRP Loads for the Illinois River, Baron Fork and Caney Creek for 2005-2007 Estimated Using LOADEST

			1/6/2008 AMLE Loads	Dr. Wells Model	Dr. Wells Model	
		Engel Produced	Provided by Engel to Wells	Calibration Tributary	Calibration Tributary	"Corrected"
	Engel Expert Report	Materials	to Develop Boundary	Run 200 Inputs	Run 400 Inputs	SRP Loads (LOADEST
Year	Table 5.3	(i.e., p model 10 15.xls)	Conditions	(May 2008 Expert Report)	(8/26/2008 Errata)	applied to 2005-2007)
2005	not presented	not presented	158,146	155,270	155,270	122,899
2006	not presented	not presented	95,198	90,016	90,016	77,806
2007 (Jan-Sep)	not presented	not presented	130,727	125,853	125,853	108,667

APPENDIX D

ERRORS IN GLEAMS MODEL INPUT AND OUTPUT FILES

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Errors in Setting Simulation Time Periods for Hydrology Input Files in Dr. Engel's GLEAMS Scenario Runs Table D-1.

GLEAMS Scenario Output Review is Based on the Following Produced Files/Materials:

I) N. URWLAWI Expert. Reports/Engel/Materials/Gleams. Final I. I. FUTURE_1007R/BARRONFORT. 2) N: IRWLAWI Expert. Reports/Engel/Materials/Gleams_Final I. I. FUTURE_1007R_NOLitter/BARRONFORT.

3) N./IRWLAWI/Expert_Reports/Engel/Materials/Gleams_Final/1.2.FUTURE_50YR_GrowthPoultry/ULL/NOIS

3) N. YRWLAWI Expert_Reports Engel Engel Errata Errata 09040831 I. FUTURE 100YR_NOLitter Clean Soil zip 11.1. FUTURE_100YR_NOLitter Clean Soil BARRONFORT 4) N. JRWLAWI Expert Reports Engel Materials Gleams Final 2. LAST 50YR variable Litter ILLINOIS

6) "HRU Summary" worksheet in this workbook

Summary of Errors in Setting the Simulation Period in GLEAMS Hydrology Input Files

Danielle of Live of the Comments of the Comments	S	2	*					
Scenario Description	GLEAMS Scenario Name	Subwatershed	Simulation Period (as specified in GLEAMS)	Simulation Period (intended for GLEAMS)	"HXX.PAR"	Land Use (as specified in GLEAMS)	Drainage Area (acres) (as specified in GLEAMS)	Notes
Waste for Growth	1.2.FUTURE_50YR_GrowthPoultry	Illinois River	1956-2012	1950-2006	HI5.PAR	pasture	3,023.6	HBDATE (1956) & HBYR (1950)/HEYR (2006) are mismatched in the hydrology input file.
Historical	2.LAST_50YR_variable Litter	Illinois River	1956-2006	1950-2006	H15.PAR	pasture	3,023.6	HBDATE (1956) & HBYR (1950)/HEYR (2006) are mismatched in the hydrology input file.
Continued Waste Application	1.1.FUTURE_100YR	Baron Fork	1950-2006	1901-2000	H18.PAR	forest	20,658.6	Incorrect simulation period specified for HBDATE (1950) & HBYR (1950)/HEYR (2006) inputs.
Continued Waste Application	1.1.FUTURE_100YR	Baron Fork	1950-2006	1901-2000	H19.PAR	forest	6,011.2	Incorrect simulation period specified for HBDATE (1950) & HBYR (1950)/HEYR (2006) inputs.
Waste Application Cessation	1.1.FUTURE_100YR_NOLitter	Baron Fork	1950-2006	1901-2000	H18.PAR	forest	20,658.6	Incorrect simulation period specified for HBDATE (1950) & HBYR (1950)/HEYR (2006) inputs.
Waste Application Cessation	L.LFUTURE_100YR_NOLitter	Baron Fork	1950-2006	1901-2000	H19.PAR	forest	6,011.2	Incorrect simulation period specified for HBDATE (1950) & HBYR (1950)/HEYR (2006) inputs.
No Waste + Background Soil P	1.1.FUTURE_100YR_NOLitter_CleanSoil	Barou Fork	1950-2006	1901-2000	H18.PAR	forest	20,658.6	Incorrect simulation period specified for HBDATE (1950) & HBYR (1950)/HEYR (2006) inputs.
No Waste + Background Soil P	1.1.FUTURE_100YR_NOLitter_CleanSoil	Baron Fork	1950~2006	1901-2000	H19.PAR	forest	6,011.2	Incorrect simulation period specified for HBDATE (1950) & HBYR (1950)/HEYR (2006) inputs.
	,							

Definitions for Abbreviations:

NA = Not applicable

HBDATE = The beginning date (year and Julian day) for hydrology simulation. HBYR = Beginning year of hydrology simulation, used to set rotation for reuse of parameters. HEYR = Ending year of hydrology simulation, used to set rotation feature.

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Errors in Simulation Outputs for Hydrology and Nutrient Files for Dr. Engel's GLEAMS Scenario Runs Table D-2.

Summary of Simulation Output Errors in GLEAMS Hydrology (HXX.OUT) and Nutrient (NXX.OUT) Output Files

nary of Simulation Culput	mary of Similation Culput Errors in OLEANAS Alyanotogy (1188.001) and American (1888.001) Culput Luca	10000	na itaniecas (112)	2000	pur i mo					
			Simulation Period		"HXX.OUT"		"NXX.OUT"	Land Use	Drainage Area	
Scenario Description	GLEAMS Scenario Name	Subwatershed	(as specified in	"HXX.OUT"	End Date for Output	"NXXOUT"	End Date for Output	(as specified in	(acres)	Notes
			GLEAMS)		(Year, Day)		(Year, Day)	GLEAMS)	(as specifica in	
Continued Waste Amplication	1.1.FUTURE 100YR	Baron Fork	1901-2000	H15.0UT	1922, 355	NISOUT	1922, 358	urban	236.6	
Continued Waste Application	L.EUTURE 100YR	Caney Creek	1901-2000	H01.0UT	1915, 075	N01.OUT	1915, 085	pasture	20,658.60	
Continued Waste Application	1.1.FUTURE 100YR	Caney Creek	1901-2000	H04.OUT	1955, 048	N04.OUT	1955, 050	urban	862.5	
Continued Waste Application	1.1.FUTURE 100YR	Illinois River	1901-2000	H64.0UT	NA	N04,OUT	NA	crop	145.9	No output for hydrology or nutrients
Continued Waste Application	J.I.FUTURE 100YR	Illinois River	1901-2000	H16.OUT	1923, 007	N16.0UT	1923, 008	urban	7,955.1	A STATE OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN TWO IS NAMED IN COLUMN
Continued Waste Application	LL-FUTURE 100YR	Illinois River	1901-2000	H20.0UT	1923, 007	N20.OUT	1923, 008	urban	539.3	
Waste Application Cessation	1.1 FUTURE 100YR NOLitter	Baron Fork	1901-2000	HISOUT	1922, 355	NIS.OUT	1922, 358	urban	236.6	
Waste Ambigation Cossation	1 FIJTURE 100YR NOLitter	Caney Creek	1901-2000	H04.OUT	1955, 048	N04.OUT	1955, 050	urban	862.5	
Waste Application Cresation	1 1 FUTURE 190YR NOLitter	Illinois River	1901-2000	H04.OUT	N.A.	N04.OUT	NA	ctop	145.9	No entirent for hydrology or nutrients
Waste Amblication Cossition	1 I FUTURE 100YR NOLitter	Illinois River	1901-2000	H16.OUT	1923, 007	NIGOUT	1923, 008	ıarban	7,955.1	
Waste Ambigation Cossition	1 1 FUTURE 100YR NOLitter	Illinois River	1901-2000	H20.OUT	1923, 007	N20.OUT	1923, 008	ıırban	539.3	
No Waste + Background Soil P	1 1 FUTURE 100YR NOLitter CleanSoil	Baron Fork	1901-2000	H15.OUT	1922, 355	NIS.OUT	1922, 358	urban	236.6	
No Weste + Background Soil P		Caney Creek	1901-2000	H04.OUT	1955, 048	N04.OUT	1955, 050	urban	862.5	
No Waste + Background Soil P	1.1 FUTURE 100VR NOLitter CleanSoil	Hinois River	1901-2000	H04.01.5T	AA	N04.OUT	NA	crop	145.9	No output for hydrology or nutrients
No Waste + Backeround Soil P	1.1 FUTURE 100YR NOLitter CleanSoil	Illinois River	1901-2000	F116.OUT	1923, 007	N16.OUT	1923, 008	urban	7,955.1	
No Waste + Background Soil P	1.1.FUTURE 100YR NOLliter CleanSoil	Illinois River	1901-2000	H20.OUT	1923, 007	N20.OUT	1923, 008	urban	539.3	
Waste for Growth	1.2.FUTURE 50YR GrowthPaultry	Baron Fork	1950-2006	H15.OUT	1962,007	N15.OUT	1962, 010	urban	236.6	
Waste for Growth	1.2.FUTURE 50YR GrowthPoultry	Illinois River	1950-2006	H04.OUT	NA	N04,OUT	NA	crop	145.9	No output for hydrology or nutrients
Waste for Growth	1.2 FUTURE 50YR GrowthPaultry	Illinois River	1950-2006	H16.OUT	1972, 007	N16.0UT	1972, 008	urban	7,955.1	
Waste for Growth	1.2 FUTURE SOYR GrowthPoultry	Illinois River	1950-2006	HZ0.OUT	1972,007	NZ0.0UT	1972, 008	urban	539.3	
Historical	2 LAST 50YR variable Litter	Baron Fork	1950-2006	H15.OUT	1973, 099	N15.OUT	1973, 102	urban	236.6	
Historical	2.LAST 30YR variable Litter	Illinois River	1950-2006	H04.OUT	NA	N04.OUT	NA	crep	145.9	No output for hydrology or nutnents
Historical	2.LAST 50YR variable Litter	Illinois River	1950-2006	H16.OUT	1999, 007	N16.OUT	1999, 007	urban	7.955.1	
Histories	7 LAST SOVR variable Litter	Illinois River	1950-2006	HZ0.OUT	1999, 007	N20.OUT	1999, 1007	urban	539.3	

Definitions for Abbreviations: NA = Not applicable

CLEAMS Scenario Hydrology and Nintrient Output Review is Based on the Following Produced Files/Materials:

N. SIRILAN STEPACT Repeats Engents English Small LITTINE (1907). Subjects a State Over CAMETCREEK*

1) N. SIRILAN Stepact Repeats English Materials Glooms. Final I. FUTURE 1907. NOLINGS** STAR RONNORT**, and "CAMETCREEK**

1) N. SIRILAN Stepact Repeats English Materials Glooms. Final I. L. STATE, 500R. Somithe Lines: subjectes "HARONFORT", and "CAMETCREEK**

5) N. SIRILAN Stepact Repeats English Materials Glooms. Final I. L. STATE, 500R. Somithe Lines: subjectes "HARONFORT", and "CAMETCREEK"

5) N. SIRVAL MELECAM Repeats English State

APPENDIX E

PARTIAL SUMMARY OF MISCELLANEOUS ERRORS AND LACK OF DOCUMENTATION

"Expert Report" refers to "Poultry Waste Generation and Land Application in the Illinois River Watershed and Phosphorus Loads to the Illinois River Watershed Streams and Rivers and Lake Tenkiller, Expert Report of Dr. B. Engel, For State of Oklahoma, In Case No. 05-CU-329-GKF-SAJ, State of Oklahoma v. Tyson Foods, et al. (In the United States District Court for the Northern District of Oklahoma), Dr. B. Engel, P.E. Professor of Agricultural and Biological Engineering, May 22,2008"

"Expert Report – Errata September, 4, 2008" refers to "Errata to Poultry Waste Generation and Land Application in the Illinois River Watershed and Phosphorus Loads to the Illinois River Watershed Streams and Rivers and Lake Tenkiller, Expert Report of Dr. B. Engel, For State of Oklahoma, In Case No. 05-CU-329-GKF-SAJ, State of Oklahoma v. Tyson Foods, et al. (In the United States District Court for the Northern District of Oklahoma), Dr. B. Engel, P.E., Professor of Agricultural and Biological Engineering, September 4, 2008."

"Expert Report – Correction to Errata September, 4, 2008" refers to "Correspondence between David Page and Robert George on October 17, 2008, subject RE: Engel Errata & Declaration"

The list below provides a summary of errors, internal inconsistencies, incorrect unit conversions, incorrect labeling and missing or incomplete documentation in the application of the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) model and the routing model to the Illinois River Watershed (IRW) by Dr. Bernard Engel.

1. On Page D-4 in Appendix D of the expert report, Table 1 lists the rainfall stations used to develop rainfall inputs for the GLEAMS model application to the Illinois River, Baron Fork and Caney Creek subwatersheds. However, the rainfall stations listed under each subwatershed do not match the actual rainfall stations used to develop the rainfall inputs required to simulate hydrology with the GLEAMS model. Below is a comparison between the weather station table provided in Table 1 on Page D-4 of the expert report and a corrected table with the actual rainfall stations used to develop rainfall inputs for Illinois River, Baron Fork and Caney Creek subwatersheds.

Table 1. Weather stations used to model Baron Fork, Illinois River, and Caney Creek Basins.

((Original	tab	le as	provid	ted	on I	bage	D-4	in A	Ippendix	D	of	the	experi	repor	T.)
----	----------	-----	-------	--------	-----	------	------	-----	------	----------	---	----	-----	--------	-------	-----

	Baron Fork	Illinois River	Caney Creek
Rainfall Stations	035354, 348506	032444, 344672,	348506
		348677	
Temperature Stations	9450	9450	9450

(Corrected table with the actual rainfall stations used in the GLEAMS model application for each subwatershed. The red font indicates the rainfall stations that were not listed as sources of rainfall data in the expert report.)

	Baron Fork	Illinois River	Caney Creek
Rainfall Stations	035354, 348506,	035354, 348506,	035354
	344672, 348677	344672, 348677	
Temperature Stations	9450	9450	9450

In addition to the missing rainfall stations listed above, rainfall data from station 32444 (also 032444), listed under the Illinois River subwatershed in Table 1, were never used to develop rainfall inputs for GLEAMS model application to the Illinois River subwatershed.

2. The approach used to develop rainfall inputs for the IRW GLEAMS model application is provided on Page D-4 in Appendix D of the expert report; however, the approach that is described on Page D-4 is inconsistent with the actual approach used to develop the GLEAMS rainfall inputs, and is also inconsistent with Figure 4 on Page D-6 in Appendix D of the expert report.

The description of the approach used to develop rainfall inputs for the IRW GLEAMS model application in the expert report is as follows:

"There are several weather stations in the Illinois River Basin. Various precipitation patterns need to be considered in GLEAMS model application. Therefore, the distribution of weather gage station was generated as Arcview (GIS) point data using latitude and longitude information of weather stations at the NCDC website (Figure 4). Thessien polygons for the weather stations were generated using the weather station gage location data (Figure 4) to identify appropriate rainfall gages to use for locations within the Illinois River Watershed. All weather stations have not been monitored continuously and most weather stations which are being monitored for rainfall have not been monitored for temperature at the same station. Table 1. Shows the selected weather stations which are operated currently."

The approach described in the expert report indicates that "Thessien polygons for the weather stations were generated ... to identify appropriate rainfall gages to use for locations within the Illinois River Watershed." However, based on a review of the IRW GLEAMS model input files, one rainfall input deck (PCP01.dat, from produced materials,

Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final\...subfolders "ILLINOIS", BARRONFORT", and "CANEYCREEK") is based on rainfall data from a single rainfall station (35354, also 035354). This rainfall input deck (PCP01.dat) was applied to the entire Caney Creek subwatershed drainage area, to approximately 1/3 of the Baron Fork subwatershed drainage area, and to approximately 1/2 of the Illinois River subwatershed drainage area.

In addition, a second rainfall input deck (PCP10.dat, from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final\...subfolders "ILLINOIS", BARRONFORT") is based on a compilation of rainfall data

from the various rainfall stations listed in Table 1 (i.e., the second rainfall input deck was compiled using 39 months of data from 35354 (or 035354), 68 months of data from 348506, 11 months of data from 348677, and 2 months of data from 344672.). This rainfall input deck (PCP10.dat) was applied to approximately 2/3 of the Baron Fork subwatershed drainage area and to approximately 1/2 of the Illinois River subwatershed drainage area.

The rainfall input decks described above (PCP01.dat and PCP10.dat) were used as inputs to the IRW GLEAMS model in all of the scenario model runs ("1.1.FUTURE_100YR", "1.1.FUTURE_100YR_NOLitter", "1.2.FUTURE_50YR_GrowthPoultry", and "2.LAST_50YR_variable Litter" located in the following directory: Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final and "1.1.FUTURE_100YR_NOLitterCleanSoil" located in the following directory: Engel\First_Errata\Produced_Considered_Materials).

Also, in addition to the inconsistency between the rainfall input development approach that was described in the expert report and what was actually done in the IRW GLEAMS model application, the rainfall stations listed for the Illinois River subwatershed are inconsistent between Table 1 on Page D-4 and Figure 4 on Page D-6. The rainfall stations listed in Table 1 include: 32444 (also 032444), 344672 and 348677. In contrast, the IRW (Illinois River, Baron Fork and Caney Creek subwatersheds) map overlain with the Thiessen polygons in Figure 4 indicate that the rainfall stations for the Illinois River subwatershed include: 32444 (also 032444), 344672, 348677, 348506, and 35354 (also 035354).

- 3. The number of total poultry houses in the study area (3,536) used to calculate the rate of total litter applied in each zone (1,2,3 and 4) on Page D-18 in Appendix D of the expert report is not the same number of total poultry houses in the study area (3,662) listed on Page D-15 in Appendix D of the expert report.
- 4. In the GLEAMS model, the hydrology input files have an input parameter named FOREST, which requires the user to indicate whether the field being modeled is an agricultural site or a forestry site. In the IRW GLEAMS model application, the Illinois River subwatershed hydrology input file for crop (H04.PAR) has a FOREST code of 3, which tells the model that the field is a mixed pine-hardwood forest. The correct FOREST code should be 0, which would tell the model that the field is an agricultural field. This error is present in all of the scenario model runs ("1.1.FUTURE_100YR", "1.1.FUTURE_100YR_NOLitter", "1.2.FUTURE_50YR_GrowthPoultry", and "2.LAST_50YR_variable Litter" located in the following directory: Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final and "1.1.FUTURE_100YR_NOLitterCleanSoil" located in the following directory: Engel\First Errata\Produced_Considered_Materials).

- 5. In the IRW GLEAMS model application, the Illinois River subwatershed hydrology input file for HRU 11 (H11.PAR, from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials \Materials\Gleams_Final\1.1.FUTURE_100YR\ILLINOIS\H11.PAR) contains an incorrect land use description. The description field in the hydrology input file indicates that the land use being modeled is pasture; however, the FOREST parameter input value specified in the hydrology input file (FOREST = 1, tells the model that the site is a long leaf conifer forest) and the nutrient input file specified (1NF.PAR) for HRU 11 indicates that the land use modeled is actually forest and not pasture. This error is present in all of the scenario model runs ("1.1.FUTURE_100YR", "1.1.FUTURE_100YR_NOLitter", "1.2.FUTURE_50YR_GrowthPoultry", and "2.LAST_50YR_variable Litter" located in the following directory: Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final and "1.1.FUTURE_100YR_NOLitterCleanSoil" located in the following directory: Engel\First_Errata\Produced_Considered_Materials).
- 6. In the IRW GLEAMS model application, the Illinois River subwatershed hydrology input file for HRU 01 (H01.PAR, from produced materials, Engel\Original Expert Report\Produced Considered Materials \Materials\Gleams Final\1.1.FUTURE 100YR\ILLINOIS\H01.PAR) contains a drainage area that is inconsistent with the drainage area listed for HRU 01 in the "code ILL.xls" file (from produced materials, Engel\Original Expert Report\Produced Considered Materials \Materials\GLEAMS\Application\Runoff Cal\Illinois River\ code ILL.xls). The drainage area for HRU 01 in the H01.PAR file is 8,048.20 acres. The drainage area for HRU 01 in the "code ILL.xls" file is 80,438.2 acres. This inconsistency is present in all of the scenario model runs ("1.1.FUTURE 100YR", "1.1.FUTURE_100YR_NOLitter", "1.2.FUTURE_50YR_GrowthPoultry", and "2.LAST_50YR variable Litter" located in the following directory: Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final and "1.1.FUTURE_100YR_NOLitterCleanSoil" located in the following directory: Engel\First Errata\Produced Considered Materials).
- 7. The following Baron Fork HRU's were found to have duplicate drainage areas specified in the GLEAMS hydrology input files (e.g., HXX.PAR): HRU 6 and HRU 16, HRU 7 and HRU 17, HRU 8 and HRU 18, HRU 9 and HRU 19, and HRU 10 and HRU 20 (from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials \Materials\Gleams_Final\1.1.FUTURE_100YR\ BARRONFORT\....HXX.PAR). This error is present in all of the scenario model runs ("1.1.FUTURE_100YR", "1.1.FUTURE_100YR_NOLitter", "1.2.FUTURE_50YR_GrowthPoultry", and "2.LAST_50YR_variable Litter" located in the following directory:

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Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final and "1.1.FUTURE_100YR_NOLitterCleanSoil" located in the following directory: Engel\First_Errata\Produced_Considered_Materials).

The table below provides a summary of the duplicate drainage areas (highlighted in gray) for the HRU's listed above.

			Drainage Area	Drainage
Subwatershed	HRU	Land Use	(ha)	Area (acres)
Baron Fork	1	pasture	2886.028	7131.4
Baron Fork	2	pasture	5788.891	14304.4
Baron Fork	3	pasture	4253.04	10509.3
Baron Fork	4	pasture	312.9491	773.3
Baron Fork	5	urban	11.97891	29.6
Baron Fork	- 6	urban	52.28634	129.2
Baron Fork	7	forest	888.6654	2195.9
Baron Fork	8	forest	7160.76	17694.301
Baron Fork	9	forest	2432.691	6011.2
Baron Fork	10	forest	8.984185	22.2
Baron Fork	11	pasture	30088.92	74350
Baron Fork	12	pasture	353.2565	872.9
Baron Fork	13	pasture	83.4477	206.2
Baron Fork	14	pasture	2922.126	7220.6
Baron Fork	15	urban	95.75036	236.6
Baron Fork	16	urban	52.28634	129.2
Baron Fork	17	forest	888.6654	2195.9
Baron Fork	18	forest	7160.76	17694.301
Baron Fork	19	forest	2432.691	6011.2
Baron Fork	20	forest	8.984185	22.2
Baron Fork	1-20	Total Area	67,883.16	167,739.90

8. In the IRW GLEAMS model application, the Illinois River subwatershed hydrology input file for HRU 15 (H15.PAR) in the waste for growth scenario (from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials \Materials\Gleams_Final\1.2.FUTURE_50YR_GrowthPoultry\ILLINOIS\H15.PAR) and the historical scenario (from produced materials Engel\Original_Expert_Report\Produced_Considered_Materials Materials\Gleams_Final\2.LAST_50YR_variable Litter\ILLINOIS\H15.PAR) contains an incorrect parameter input value for HBDATE, which tells the model the beginning date for the hydrology simulation. The parameter input value for HBDATE specified in the H15.PAR file is HBDATE=195600 (Year=1956). The correct year in the beginning date for the hydrology simulation is HBDATE=1950000 (Year=1950) based on the HBYR parameter input value (HBYR=1950, Year=1950), which tells the model the beginning year of the hydrology simulation in the H15.PAR input file. The error in

- setting the year in HBDATE resulted in an incorrect simulation period for HRU 15 in both the waste for growth and historical scenarios (see Table D-1, Appendix D).
- 9. In the IRW GLEAMS model application, the Baron Fork subwatershed hydrology input files for HRU 18 (H18.PAR) and HRU 19 (H19.PAR) in the continued waste application scenario (from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials \Materials\Gleams_Final\1.1.FUTURE_100YR\ BARRONFORT\H18.PAR and ... \H19.PAR) have the wrong simulation period specified. The simulation period for HRU 18 and HRU 19 is set at 1950-2006 (56 years); however, the correct simulation period (as specified in the other GLEAMS hydrology inputs files HXX.PAR) is 1901-2000 (100 years) (see Table D-1, Appendix D).
- 10. In the IRW GLEAMS model application, the Illinois River subwatershed hydrology (H04.OUT) and nutrient (N04.OUT) output files for crop do not generate any hydrology or nutrient output in any of the GLEAMS model scenarios that the expert report is based upon (see Table D-2, Appendix D). This error is present in all of the scenario model runs ("1.1.FUTURE_100YR", "1.1.FUTURE_100YR_NOLitter", "1.2.FUTURE_50YR_GrowthPoultry", and "2.LAST_50YR_variable Litter" located in the following directory:

 Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final and "1.1.FUTURE_100YR_NOLitterCleanSoil" located in the following directory:

 Engel\First_Errata\Produced_Considered_Materials).
- 11. In the IRW GLEAMS model application, there are output errors in the hydrology and nutrient output files for some of the Illinois River, Baron Fork and Caney Creek HRU's. One example of the output error referenced above is as follows: In the continued waste application scenario ("1.1.FUTURE_100YR", from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final), the Illinois River subwatershed hydrology (H20.OUT) and nutrient (N20.OUT) output files for HRU 20 do not contain any model output after day 7 (hydrology) and day 8 (nutrients) of the year 1923 even though the simulation period is set for 1901 to 2000 in this GLEAMS scenario. For further details and a summary of similar output errors in various GLEAMS scenarios, see Table D-2 in Appendix D.
- 12. In the GLEAMS model, the nutrient input files have an input parameter named CLAB, which represents labile phosphorus concentration in the soil horizon. In the IRW GLEAMS model application, the Illinois River subwatershed nutrient input files for pasture (1NP.PAR and 2NP.PAR, from produced materials Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final\1.1.FUTURE_100YR\ILLINOIS\1NP.PAR, ...\2NP.PAR) in the continued waste application scenario (i.e., scenario includes the 1998-2006 phosphorus loads from Dr.

Engel's phosphorus calibration per the e-mail from David Page to Robert George, Louis Bullock; David Riggs, and Elizabeth Claire Xidis on Wednesday, August 13, 2008 8:27 AM, subject "RE: Follow Up Items from July 11 Teleconference with Dr. Engel", stated "...Running YEARLYTP.EXE in the respective subwatershed folders in the 1.1.FUTURE_100YR folder will create a set of outputs including a daily.out file with daily loads. The first 10 years of data in these daily.out files is calibration data for 1997-2006....".) contain CLAB input values that are outside the optimization range set forth in SCE.DAT file (from produced materials,

Engel\Original_Expert_Report\Produced_Considered_Materials \Materials\Gleams_Final\1.1.FUTURE_100YR\ILLINOIS\SCE.DAT") used in the automated calibration procedure (SCE-UA) of GLEAMS (see Page D-20 in Appendix D of the expert report). The CLAB input values in the 1NP.PAR file range from 37.5-61.7 μ g/g and the CLAB input values in the 2NP.PAR file range from 69.4-114.2 μ g/g. In contrast, the optimization range set forth in the SCE.DAT file for CLAB ranges from 100-300 μ g/g.

Furthermore, the CLAB input value ranges set forth in the SCE.DAT file are inconsistent with how the optimization ranges were described to have been set in the expert report. That is, on Page D-20 in Appendix D of the expert report the following is stated:

"Calibration parameters were selected by referring to the GLEAMS manual. The GLEAMS manual explains which parameters are most sensitive. Most parameters were generated based on observed data and documented databases so the optimization range was set as $\pm 50\%$ of estimated values to avoid searching extreme values and to insure that calibrated parameters were within reasonable ranges."

The CLAB ranges (100-300 $\mu g/g$) set forth in the SCE.DAT file do not represent $\pm 50\%$ of the observed CLAB values listed in Table 6 on Page D-16 in Appendix D of the expert report.

13. In the IRW GLEAMS model application, the Baron Fork subwatershed nutrient input file for pasture (1NP.PAR, from produced materials Engel\Original_Expert_Report\Produced_Considered_Materials \Materials\Gleams_Final\1.1.FUTURE_100YR\BARRONFORT\1NP.PAR) in the continued waste application scenario (i.e., scenario includes the 1998-2006 phosphorus

continued waste application scenario (i.e., scenario includes the 1998-2006 phosphorus loads from Dr. Engel's phosphorus calibration per e-mail communication referenced in item #12) contain CLAB input values that are outside the optimization range set forth in SCE.DAT file (from produced materials,

Engel\Original Expert_Report\Produced_Considered_Materials

\Materials\Gleams_Final\1.1.FUTURE_100YR\BARRONFORT\SCE.DAT) used in the automated calibration procedure (SCE-UA) of GLEAMS (see Page D-20 in Appendix D of the expert report). The CLAB input values in the 1NP.PAR file range from 37.6-61.9

 $\mu g/g$. In contrast, the optimization range set forth in the SCE.DAT file for CLAB ranges from 80-150 $\mu g/g$.

- 14. In the IRW GLEAMS model application, the Caney Creek subwatershed nutrient input file for pasture (1NP.PAR, from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials \Materials\Gleams_Final\1.1.FUTURE_100YR\ CANEYCREEK\1NP.PAR) in the continued waste application scenario (i.e., scenario includes the 1998-2006 phosphorus loads from Dr. Engel's phosphorus calibration per e-mail communication referenced in item #12) contain CLAB input values that are outside the optimization range set forth in SCE.DAT file (from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials \Materials\Gleams_Final\1.1.FUTURE_100YR\CANEYCREEK\SCE.DAT) used in the automated calibration procedure (SCE-UA) of GLEAMS (see Page D-20 in Appendix D of the expert report). The CLAB input values in the 1NP.PAR file range from 24.3-40.0 μg/g. In contrast, the optimization range set forth in the SCE.DAT file for CLAB ranges from 80-150 μg/g.
- 15. The original "actual_and_no_litter4_5.xls" (continued waste application and waste application cessation scenario routing model workbook from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials\Bernard Engel considered materials\actual_and_no_litter4_5.xls) and the errata "actual_and_no_litter8_30.xls" (continued waste application and waste application cessation scenario routing model workbook from produced materials, Engel\First_Errata\Produced_Considered_Materials\actual_and_no_litter8_30.xls) contain labeling errors in the "Year" label that is used to correlate a particular time (e.g., day/year) with a simulated phosphorus load. The "Year" label in both the summarized GLEAMS output and the summarized routing model output skips years 2047 to 2056.
- 16. The original "buffer_no_litter.xls" (buffer scenario routing model workbook from produced materials,

 Engel\Original_Expert_Report\Produced_Considered_Materials\Bernard Engel considered materials\buffer_no_litter.xls) and the errata "buffer_no_litter8_30.xls" (buffer scenario routing model workbook from produced materials,

 Engel\First_Errata\Produced_Considered_Materials\buffer_no_litter8_30.xls) contain labeling errors in the "Year" label that is used to correlate a particular time (e.g., day/year) with a simulated phosphorus load. The "Year" label in both the summarized GLEAMS output and the summarized routing model output skips years 2047 to 2056.
- 17. The "historical_50_99_8_30.xls" workbook, "nps" worksheet (historical scenario routing model workbook from produced materials, Engel\First_Errata\Produced_Considered_Materials\historical_50_99_8_30.xls)

- mislabels nonpoint source only loads as nonpoint source plus wastewater treatment plant (WWTP) loads for the Illinois River (Column V), Baron Fork (Column AB), and Caney Creek (Column AD) subwatersheds.
- 18. The historical (1950-1999) annual loads from the Illinois River, Baron Fork and Caney Creek subwatershed to Lake Tenkiller are incorrect for 25 years out of the 50 years evaluated in the "historical_50_99_8_30.xls" workbook, "nps" and "50 yr" worksheets (historical scenario routing model workbook from produced materials, Engel\First_Errata\Produced_Considered_Materials\historical_50_99_8_30.xls). The error in the annual load summaries arises from an incorrect accounting of the years that are leap years. For example, the annual load for 1952, which is a leap year, only includes 365 days of daily loads and does not include a daily load on day 366. In contrast, the annual load for 1953, which is not a leap year, includes the daily load on day 366 of 1952 plus the other 365 days in 1953 that are actually part of the year 1953. This type of calculation error continues to repeat every two years over the entire 50 year period. The historical scenario results that include these errors are presented on Pages 36-41 of the expert report Errata September, 4, 2008.
- 19. The continued poultry waste application and poultry waste application cessation annual loads from the Illinois River, Baron Fork and Caney Creek subwatersheds to Lake Tenkiller were incorrectly calculated for years 2010 (year 10) and 2047-2096 (years 51-100) in the "current_and_no_litter100_8_30.xls" workbook, "cont_cessation" worksheet (from produced materials, Engel\First_Errata\Produced_Considered_Materials\current_and_no_litter100_8_30.xls). The subwatershed annual loads for year 2010 (year 10) include the daily load from day 365 of year 2009. The subwatershed annual loads for years 2047-2096 (years 51-100) are shifted by one day. For example, the annual loads for year 2048 are summed from day 2 of year 2048 to day 1 of 2049.
- 20. The historical (1950-1999) annual loads from the Illinois River, Baron Fork and Caney Creek subwatersheds to Lake Tenkiller were incorrectly converted from kg to lbs in the "historical_50_99_8_30.xls" workbook, "nps" and "50 yr" worksheets (historical scenario routing model workbook from produced materials, Engel\First_Errata\Produced_Considered_Materials\historical_50_99_8_30.xls). The unit conversion factor applied to convert from kg to lbs was 0.4526; however, the correct conversion factor is 0.45359237 or 0.4536 if rounded up to the fourth significant figure. This error results in an over-estimation of the historical loads over the 50-year period for both the nonpoint source plus point source load and the nonpoint source only load results by 37,898 lbs and 21,857 lbs, respectively. The results are presented on Pages 36-41 of expert report Errata September, 4, 2008.

- 21. The observed (1998-2006) annual loads from the Illinois River, Baron Fork and Caney Creek subwatersheds to Lake Tenkiller were incorrectly converted from kg to lbs in the "p_model_10_15.xls" workbook, "Sheet 1" worksheet (from produced materials, from produced materials,
 - Engel\Second_Errata\Produced_Considered_Materials\p_model_10_15.xls). The unit conversion factor applied to convert from kg to lbs was 0.4356; however, the correct conversion factor is 0.4536. This error results in an over-estimation of the observed loads over the 9-year period by 190,682 lbs. The incorrect observed loads are presented in Table 10.1 on Page 47 of the expert report and in Table 10.1 on Page 4 of the expert report Correction to Errata September, 4, 2008.
- 22. The 1998-2006 annual GLEAMS loads (P to River) in the "allocation_5_2.xls" workbook, "allocation" worksheet (from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials\Bernard Engel considered materials\allocation_5_2.xls) do not match any of the base period (1998-2006) GLEAMS model output that was provided in Dr. Engel's produced materials.
- 23. The annual phosphorus load attributed to point source loads (WWTP's) in the "allocation_5_2.xls" workbook, "allocation" worksheet (from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials\Bernard Engel considered materials\allocation_5_2.xls) for the 1998-2002 time period was 226,164 lbs/yr (102,588 kg/yr), which is inconsistent with the annual WWTP load listed in Table 6 on Page D-19 in Appendix D of the expert report for the Early 90's to 2002 time period (204,101 lbs/yr or 92,580 kg/yr).
- 24. The "Year" labels used to identify annual loads to Lake Tenkiller from the routing model output in "Sheet 3" of the "allocation 5 2.xls" workbook (from produced materials, Engel\Original Expert Report\Produced Considered Materials\Bernard Engel considered materials\allocation_5_2.xls) are incorrect and have been mislabeled. The annual loads are labeled as routing model output from 1998-2006 (or years 2-10); however, based on the "current_and_no_litter100_4_25.xls" workbook, "no litter back p" worksheet (from produced materials, Engel\Original Expert Report\Produced Considered Materials\Bernard Engel considered materials\current_and no_litter100_4_25.xls) the correct "Year" labels based on the "no litter back p" worksheet should be 2057-2065 (or years 51-59). However, it is important to note that the 2057-2065 "Year" labels would still be incorrect because of an additional error in the "current and no litter100 4 25.xls" workbook. The "Year" labels in the routing model output in the "current and no litter 100 4 25.xls" workbook skip years 2047-2055. The correct "Year" labels for the routing model loads labeled 1998-2006 are 2047-2055. The routing model results from "Sheet 3" of the "allocation 5 2.xls" workbook are used to determine the load allocations for individual sources as summarized in Table 10.14 and Table 10.15 on Page 93 of the expert report.

- 25. The method used to add the WWTP loads to the GLEAMS nonpoint source (NPS) model output (e.g., post-processing software application or manual post-processing in an Excel workbook) was not documented in the expert report.
- 26. The expert report does not provide any documentation or explanation on how the 14 soil types, listed in Figure 5 on Page D-10 in Appendix D of the expert report, were aggregated or lumped into the four soil types listed on Pages D-14 to D-15 in Appendix D of the expert for the IRW GLEAMS model application.
- 27. The Shuffled Complex Evolution Algorithm (SCE-UA) calibration procedure was applied to the 2NP.PAR (input file for Zone 3) (from produced materials, Engel\Original Expert Report\Produced Considered Materials\CD_Received July 17 \CD Received July 17\SecondStage\ILLINOIS\2NP.PAR or Engel\Original Expert Report\Produced_Considered_Materials\Materials\ \Gleams Final\1.1.FUTURE 100YR\ILLINOIS\2NP.PAR) nutrient input file for pasture in the GLEAMS application to the Illinois River subwatershed and applied to the 1NP.PAR (input file for Zone 1 and Zone 4) (from produced materials, Engel\Original Expert Report\Produced Considered Materials\CD_Received_July 17 \CD Received July 17\SecondStage\ BARRONFORT or Engel\Original Expert Report\Produced Considered Materials\Materials\Gleams Final\ 1.1.FUTURE 100YR\BARRON FORT\1NP.PAR and Engel\Original Expert Report\Produced Considered Materials \Materials\Gleams Final\1.1.FUTURE 100YR\CANEYCREEK\1NP.PAR) nutrient input file for pasture in the GLEAMS application to the Baron Fork and Caney Creek subwatersheds. The calibration procedure for the 1NP.PAR (input file for Zone 2) (from produced materials, Engel\Original Expert Report\Produced Considered Materials\CD Received July 17 \CD_Received_July 17\SecondStage\ILLINOIS\1NP.PAR or Engel\Original Expert Report\Produced Considered Materials\Materials\Gleams Final\ 1.1.FUTURE 100YR\ILLINOIS\1NP.PAR) was not documented. The calibration procedure for the other nutrient inputs files (1NC.PAR, 1NF.PAR, and 1NU.PAR) in Zones 1-4 (from produced materials,
 - Engel\Original_Expert_Report\Produced_Considered_Materials\CD_Received_July 17\CD_Received_July 17\SecondStage\subfolders... "ILLINOIS" and "BARRONFORT" or
 - Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\Gleams_Final\ 1.1.FUTURE_100YR\ ... subfolders "ILLINOIS", BARRONFORT", and "CANEYCREEK") for crop, forest and urban land uses was also not documented.
- 28. The method and/or approach used to model buffers in the two buffer scenarios (buffers along all 3rd order and larger IRW streams; buffers along all IRW streams) presented in the expert on Pages 67-75 and the expert report Errata September, 4, 2008" on Pages

- 22-29 was not documented in either the expert report or the expert report Errata September, 4, 2008.
- 29. On Page D-18 in Appendix D of the expert report, the following statement, "Fertilizer in GLEAMS was set as animal waste (MFERT=1) for poultry waste and applied April 1 (NF=91 as Julian day)" contains an error. The parameter input for the date of fertilization in GLEAMS is denoted DF, not NF. In GLEAMS, the parameter input NF, is the number of fertilizer and animal waste applications during the update period.
- 30. The x-axis in Figure 11 on Page D-28 in Appendix D of the expert report is mislabeled. The "Year" label in x-axis ranges from 1996-2005. However, the correct "Year" label should range from 1986-1995, which is the hydrologic validation period as noted on Page D-27 in Appendix D of the expert report. Furthermore, based on the "Results2.xls" workbook (from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\GLEAMS\ Results2.xls) and the hydrology validation HYDRES.OUT file (from produced materials, Engel\Original_Expert_Report\Produced_Considered_Materials\Materials\GLEAMS\Application\Runoff_val\Illinois River\Model\HYDRES.OUT), the data plotted in Figure 11 are incorrect and do not represent the final hydrology validation results.
- 31. The x-axis in Figure 12 on Page D-28 in Appendix D of the expert report is mislabeled. The "Year" label in x-axis ranges from 1996-2005. However, the correct "Year" label should range from 1986-1995, which is the hydrologic validation period as noted on Page D-27 in Appendix D of the expert report.
- 32. The x-axes and y-axes in Figures 15, 16, 17, 18, 19, and 20 on Pages D-32 to D-34 in Appendix D of the expert report are missing constituent load labels, as well as unit labels for the daily predicted and observed phosphorus loads plotted.
- 33. The x-axes and y-axes in Figures 15, 16, 17, 18, 19, and 20 on Pages 45-48 in the expert report Errata September, 4, 2008 are missing constituent load labels, as well as unit labels for the daily predicted and observed phosphorus loads plotted.
- 34. The y-axes in Figures 10.37, 10.38, 10.39, and 10.40 on Pages 89-90 in the expert report are missing constituent concentration labels, as well as unit labels for the average phosphorus concentrations plotted.
- 35. The y-axes in Figures 10.37, 10.38, 10.39, and 10.40 on Pages 41-43 in the expert report Errata September, 4, 2008 are missing constituent concentration labels, as well as unit labels for the average phosphorus concentrations plotted.

- 36. In the expert report Errata September, 4, 2008, the Illinois River near Tahlequah calibration and validation results were switched. Figure 15 on Page 45 is incorrectly described as "Calibration for Daily P Load at Tahlequah". Based on the source file for this figure (from produced materials, Engel\Second_Errata\Produced_Considered_Materials\p_model_10_15.xls), the correct description for Figure 15 is "Validation Results for Daily P Load at Tahlequah".
- 37. In the expert report Errata September, 4, 2008, the Baron Fork at Eldon calibration and validation results were switched. Figure 16 on Page 46 is incorrectly described as "Calibration Results for Daily P Load at Baron Fork near Eldon". Based on the source file for this figure (from produced materials, Engel\Second_Errata\Produced_Considered_Materials\p_model_10_15.xls), the correct description for Figure 16 is "Validation Results for Daily P Load at Baron Fork at Eldon".
- 38. In the expert report Errata September, 4, 2008, the Caney Creek near Barber calibration and validation results were switched. Figure 17 on Page 46 is incorrectly described as "Calibration Results for Daily P Load at Caney Creek". Based on the source file for this figure (from produced materials, Engel\Second_Errata\Produced_Considered_Materials\p_model_10_15.xls), the correct description for Figure 17 is "Validation Results for Daily P Load near Caney Creek".